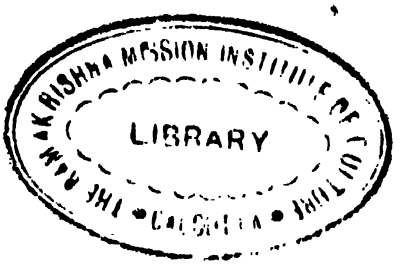
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DRUG SITUATION IN INDIA

POST-WAR reconstruction is now being freely talked of everywhere—in the Press, in the Radio, as well as in public platforms. A special portfolio has been created in the Viceroy's Cabinet on "Post-war Planning and Development", and one of our brilliant industrialists and organizers, Sir Ardeshir Dalal, has taken over charge of this important work. A special Committee on "Health Survey and Development" during the post-war period is carrying on its labours for nearly a year under Sir Joseph Bhore. Of late, several foreign experts have come down to India to advise on the tentative recommendations of this Committee. A scheme for a thorough educational reorganization to remove mass illiteracy and bring India in line with other educated countries in the civilized world has already been mooted by Sir John Sargent, the Educational Adviser to the Government of India, and has been favourably commented upon. A Fertilizers Technical Mission has visited India to advise on the setting up of plants and equipment for the manufacture of nitrogen fertilizers in commercial scale for the development of Indian agriculture. An Indian Scientific Mission has already left India for collecting first-hand information on future scientific, technical and industrial possibilities in this country, and an Industrial Mission consisting of India's leading industrialists are planning to proceed to the United Kingdom and America shortly. 'Grow More Food' campaigns have been started, and attempts are also being made to improve food technology and build up modern processed food industries in the near future in India. After years of inaction and silent waiting, there seems clear indication from all sides that there is a definite and an increasing awareness in India about the need of better and more ample provision for what may be called the very primary requirements of civilized existence—(1) Food (2) Medicine (3) Education and (4) Clothing. With the World War II coming to its closing phases, India, like many other countries of the world, would have to re-adjust herself to a 'new order' and a new standard of progress, and it is a welcome sign of the times that she is at least attempting to march ahead with this objective in view.

In any scheme of medical relief to the nation, drugs which are the chief weapons in our attack against malnutrition, disease and epidemics, would naturally form an important item for consideration. Next to the supply of food, the provision of medicines of good and dependable quality at a price within the reach of the poor masses of India is an urgent and imperative necessity. The question of drug supply, it need hardly be pointed out, is intimately related with any scheme of post-war public health planning and in every attempt that is made 'to keep the nation fit'. It would be of interest, therefore, to review the drug situation in India, to see where gaps exist in the Indian drug industry and to focus attention on the directions in which the Indian drug industry should try to guide its activities, so that it will be able to discharge its responsibilities to the nation in a more adequate and fuller measure.

The Recent Drug Crisis

The world knows that Bengal was in the grip of a severe 'food famine', but it is hardly realized that the 'drug famine' in Bengal was even worse. Those who have had something to do with relief organizations, medical aid-parties, Red Cross units, Ramkrishna Mission and other charitable organizations working in the rural areas, where malaria, typhoid, cholera, dysentery and other fevers of unknown origin were devastating the country-side, and who were frantically trying to get supplies of drugs from various sources, know to their cost the extent

and gravity of the 'drug famine' that existed in 1942-43. We have frequently read in the papers of the colossal death rates from food-famine, but no figures are available as to the extent that this mortality is referable to lack of treatment due to shortage of drugs. What is the cause of this shortage? Why could not our Indian manufacturers rise to the occasion and supply the needs?

The reasons are obvious. In the first place, India had depended for years on foreign imports for the supply of many of her essential medicaments, and consequently the drug industry in the country was not prepared to meet the needs in an emergency period. A reference to the sea-borne trade statistics of British India published by the Department of Commercial Intelligence and Statistics would show that as early as 1910 the value of imported drugs (including pharmacopoeial drugs, essential oils, proprietary medicines, medicinal chemicals, toilet products, alcohol used in drugs, spirits for perfumery, etc.) was about Rs. 75 lakhs; in 1937, the figure was about Rs. 285 lakhs, a fourfold increase in 27 years. The import of foreign proprietaries into India amounted to Rs. 33 lakhs during the years 1933-34, and this figure rose to Rs. 73 lakhs within the next four years in 1937-38. Recent figures are not easily available, but there is definite indication that up to the time when shipping facilities were available at pre-war level, India's quota in drug import was not only quite heavy but was definitely on the increase almost every year. Secondly, the demand for drugs has increased tremendously, of late, due to the entry of foreign soldiers to conduct the war, exports by the air-route to China, and also due to the higher incidence, in general, of sickness amongst civilians in war-time. Thirdly, the fall of Java, Singapore, etc., has cut off a flow of certain essential crude drugs, *e.g.*, cinchona, ipecacuanha, etc. and quinine from abroad to India. Fourthly, certain unscrupulous Indian druggists are hoarding what drugs are already in hand for selfish purposes—'profiteering'. The Government of India have taken steps to rectify the emergency situation by freezing essential drugs, by imposing heavy penalties for hoarding of drugs and by devising ways and means to halt inflation by 'price control' etc. In spite of all efforts however, there is clear indication to-day that the civilians are on the point of starvation as far as drug supply is concerned, because many of the essential items are not produced in India. One of the natural questions, that arises in this connection is whether or not the most useful drugs at least can be made in India. If so, the advantages are likely to be numerous, the important ones being self-sufficiency, low cost of production and certainty of delivery and distribution, a factor of no less importance in war time. Besides, any experience gained now will greatly facilitate post-war reconstruction and pharmaceutic development of India.

India's Drug Resources and Their Utilization

To give an opinion as to whether India is in a position to manufacture the most useful drugs, it is necessary to look into India's drug resources and to review the extent to which such resources have been properly harnessed for the benefit of the population. Drugs are usually derived from four sources:—(*a*) vegetable, (*b*) mineral, (*c*) animal, and (*d*) synthetic sources. Recently another group of substances, (*e*) anti-biotics, which are the products of the growth of a particular class of fungus, *e.g.*, *Penicillium notatum* and others, have been added to this list.

With regard to *vegetable* drugs, India's position is pre-eminent. Leaving aside for the time being the large number of drugs used in the indigenous systems of medicine, nearly three-fourths of the vegetable drugs mentioned in the British Pharmacopoeia or the United States Pharmacopoeia grow wild and in great abundance in different parts of India. India possesses such wonderful variability of temperature, soil and climatic conditions that every conceivable drug, ranging from those growing in the hottest tropical climate to those growing in temperate and cold climates, may be made to grow in her soil. Moreover, a large number of plants grow in India, which, though not exactly the same as those 'officially' recognized, have properties and actions similar to the imported and often expensive remedies and would form excellent substitutes. Examples of such drugs are numerous but few important ones which have been exploited to a certain extent, *e.g.*, digitalis, ipecac, belladonna, hyoscyamus, nux vomica, ephedra, lobelia, pyrethrum, tephrosia, cinchona, etc. may be mentioned. During the present war, it is encouraging to find that these and other crude drug resources of the country are being largely utilized not only for the preparation of tinctures, extracts, powders, etc., but also for the extraction of active principles, *e.g.*, morphine, codeine, quinine, totaquina, emetine, strychnine, ephedrine, caffeine, santonine, etc. and for the preparation of organic acids, *e.g.*, tannic, citric, etc. Many fixed oils *e.g.*, chaulmoogra, castor, cocoanut, linseed, etc., and essential oils, *e.g.*, chenopodium sandalwood, caraway, fennel, rose, cloves, cardamom, cinnamon, etc., of indigenous origin are also being widely used. A dramatic development of very great future promise has been the artificial production of ergot of rye in the Nilgiri Hills for the first time in the history of India.

In the group of drugs derived from *animal sources*, considerable development has been made. It is a fine record of Indian industry that the world shortage of cod liver oil, which was bound to have a serious repercussion on the already low nutritional level of India, has been met here, at least to a certain extent, by the utilization of the Shark liver oil. A satisfactory substitute for Spanish blister beetles (*cantharis vesicatoria*) has been found in Indian beetles of the type of *Mylabris macilenta* and local needs of cantharidin have been met from this source. Glandular products, *e.g.*, thyroid powder, adrenaline powder and posterior pituitary powder, have been successfully made from glands of animals from local slaughter houses. Huge quantities of liver extracts, both for oral and parenteral use, have also been made. Animal bile has been used as raw material for the preparation of sodium taurocholate and glycocholate and its oxidation product, dehydrocholic acid. Attempts have further been made, though as yet unsuccessfully, for the preparation of sex hormones and anterior pituitary-like hormones from natural sources. It is understood that insulin has also been prepared but it is not yet to be seen in the open market. The most outstanding conrtibution in this field has been the development of the biological products, *e.g.*, sera, vaccines, antigens, antibodies, bacteriophages, etc. for immunotherapy in its various aspects. What was at one time considered impossible to achieve in the hot and humid climatic conditions of Bengal has been successfully done, and to-day drug manufacturers in Bengal are almost in an enviable position with regard to their production capacity of antitetanic, antidiphtheric, anti-dysenteric and anti-streptococcic sera and prophylactic and curative vaccines of every description.

In *mineral wealth*, India's position has been considered very satisfactory by a number of experts. Until recently, sulphuric acid manufacturers in India were importing nearly 25,000 tons of sulphur from Italy, Japan and America. India has deposits of sulphur (native) and also 'pyrites' in Baluchisthan, which if worked, would yield at least 36,000 tons of sulphur we need for the manufacture of sulphuric acid for use in pharmaceutical and allied industries. Antimony and arsenic are also available in quantities which ought to suffice for the needs of India in respect of organic arsenical and organic antimonial compounds for the treatment of syphilis and kala-azar respectively. Silver salts and its organo-metallic compounds, *e.g.*, protargol, salts of zinc, copper, aluminium and tin, and permanganates from manganese have also been prepared from India's mineral deposits. Iron salts and its popular scale preparations have been manufactured here. India lacks in adequate supplies of bismuth and mercury, but the quantities needed for pharmaceutical purposes are not of a magnitude which cannot be secured from the borders of Burma or China.

Apart from these drugs of vegetable, animal, and mineral origin, India is very largely dependent for almost all her pure and heavy chemicals used in medicine and pharmacy and in analytical and scientific work on outside sources. In the field of *synthetic and chemotherapeutic products* which stand at the forefront of modern medical progress and which supply more than half of the modern physician's chemical weapons, this dependence is most evident. Practically the whole range of local anaesthetics, *e.g.*, procaine, and the newer general anaesthetics, *e.g.*, divinyl ether, cyclopropane, etc., the whole group of analgesics and anti-pyretics, *e.g.*, antipyrine, phenacetin, etc., the recent diuretics, *e.g.*, mersalyl, salyrgan, etc., many hypnotics, *e.g.*, the barbituric acid derivatives, (only veronal has been so far prepared), many stimulants and analeptics, *e.g.*, leptazol, nikethamide etc., vasodilators, *e.g.*, choline chloride, amyl nitrite, benzyl benzoate, etc., almost all germicides, fungicides and parasiticides, *e.g.*, mandelic acid, chloro-cresol, merthiolate, phenyl mercuric nitrate, etc., the constantly growing series of dyestuffs, *e.g.*, azo dyes, acridine and rosaniline dyes, for surface application and for diagnostic, prognostic, and radiological purposes, many essential oils, vitamins and anti-bacterial agents, *e.g.*, the sulphanilamides, etc.,—to mention only a few—must come from abroad to maintain the health of her countless millions. That it is possible to manufacture most of these in India and that qualified technical personnel are now available to undertake such synthetic and analytical work are shown by the fact that already such drugs as carbarsone, iodochloroxyquinoline, chiniofonum, atophan, sulpharsphenamine, urea stibamine, the sulphanilamides and atebrin have been manufactured on a laboratory and semi-commercial scale in India. Sex hormones of the type of stilboesterol and hexoesterol, thyroxine, and the adrenal cortical hormone, desoxycorticosterone, have also been synthesized in a small scale in certain university laboratories. Attempts are being systematically made for the synthesis of adrenaline from catechol. The greatest gap in Indian synthetic chemistry at the moment is in the direction of the synthesis of the vitamins. Thiamine chloride (vitamin B_1), riboflavine (vitamin B_2), nicotinic acid and nicotinamide (P—P factor), pyridoxine (vitamin B_6), ascorbic acid (vitamin C), and methyl napthoquinone (vitamin K-like substance), which have already been manufactured by synthetic processes in America and elsewhere, have not been attempted in this country, excepting perhaps nicotinic acid which is reported to have been prepared from tobacco wastes. Vitamin A concentrates and vitamin D are also being made by molecular distillation of fish liver oils in a Hickman Still in

America. This has been attempted in one research institute in India but has not yet been a success. All these things which have been made elsewhere and the processes regarding the manufacture of which are already well-known and are available from recognized sources, can be easily produced in India provided there is proper stimulus and leadership and a collateral development of chemical and technological industries in this country.

Production Target to be Aimed At

Within the last 30 years, thanks to the enterprising spirit of some prominent chemists and medical men, the drug industry in India has developed fairly well, particularly in the provinces of Bengal and Bombay. It will be admitted on all hands that during this war India's drug production capacity is on a much higher level than during the last war. The total Indian output is, however, very small compared to the size of the country and its large population. The Indian public are becoming more and more conscious of the wonderful achievements of 'modern medicine' (not 'Allopathy' which is almost extinct now), chemotherapy, modern surgery and obstetrics, and are gradually showing preference for this system of treatment over the old indigenous systems of medicine, *e.g.*, Ayurvedic, Unani, Hakimi, etc., which used to claim as their adherents nearly ninety per cent. of India's population until the beginning of this century. A naturally growing demand for modern drugs is, therefore, slowly but surely being created. If, as is expected, as a result of international trends towards socialization of medicine and the recommendations of the 'Health Survey and Development Committee', public health and medical care become a Governmental function immediately after the war is over, India can easily look forward to an enormous drug market within her own borders. For a very much smaller population, Great Britain incurs an expenditure of £80,000 on drugs, medical research, etc. under the National Health Insurance Scheme. If we calculate the cost of medical relief and medical care of the Indian population under a similar Health Insurance Scheme at the modest estimate of 0·1 per cent. of the national income (estimated by Sir J. C. Ghosh at Rs. 65 per head per year), India would require supplies of drugs and other medical requisites valued at 5 crores of rupees. Considering the low nutritional status of the Indian public and their still lower resistance to disease and infections, protective drug therapy with vitamins and preventive inoculations with vaccines against typhoid, cholera, dysentery, etc. may have to be carried on by the Government with much more emphasis than in Great Britain and in America, at least for the next 15 years during the post-war period. All these steps would naturally require far more energetic drug production than at present. Apart from State needs, there will be private needs for drugs also, whose proportions cannot be ignored. With better industrial development and increase of agricultural resources, India's buying capacity for drugs would undoubtedly increase to at least 10 times more than at present. The scope of expansion and further development of the Indian drug industry can, therefore, be easily imagined. It is not enough to supply a fraction of the requirements of the people, as at present, but the aim should not only be to attain self-sufficiency but also to develop an export trade, at least in vegetable drugs.

During recent years, there are welcome evidences of rapidly growing, though often spasmodic, interest in the building up of newer drug manufacturing industries from the raw materials available in this country. While this is a very hopeful sign, and is a move in the right direction, it cannot be denied that because of lack of proper organization, many such efforts are not meeting with the success they deserve. The development of drug industry, unlike most other industries, is not merely a function of capital and labour and cannot be done by amateurs and novices but should be established on scientific lines under the expert guidance of chemists, chemical engineers, pharmacists and pharmacologists possessing a good knowledge of the technology of the industry. This is not often appreciated by many of the Indian industrialists and capitalists who want a quick turnover and a rapid piling up of their bank balances, not by the slow and often tedious scientific methods but by 'magical' methods. Once this attitude changes, substantial progress will surely be made. The field is so vast in India that there is no fear of 'internal' competition for years to come.

Drug Industry's Difficulties

The difficulties in the way of arriving at this target are many and varied. Some of the major ones may be briefly mentioned here.

(A) Lack of development of chemical and allied industries:—

(*i*) *Chemical industry.*—As drugs are primarily chemicals, their manufacture will naturally be conditioned by the development of the chemical industry in general. Most of our leaders cry themselves hoarse complaining against the poor development of pharmaceutical industry in this country and are often in the habit of laying the blame at the doors of our pharmaceutical manufacturers. They fail to realize that pharmaceutical manufacture is only the final stage of an industry whose roots are deeply laid in the chemi-

cal industry. Like tailors working on cloth made in a separate factory, pharmaceutical manufacturers have to carry on their work with chemicals produced by the chemical industry. In no country in the world pharmaceutical industry can be self-sufficient with regard to all its needs, and it has always depended primarily on a well-developed chemical industry. In most instances, pharmaceutical industries are really outgrowths of dye, coal-tar and heavy chemical industries. The great Bayer Corporation of Germany was initially a 'Farbenindustrie' (a dye-making corporation). In India, we have to face the peculiar situation of the cart (pharmaceutical industry) coming before the horse and this is the most important reason for the lack of development of India's pharmaceutical industry.

From the view point of drug production, the chemical industry may be divided under the following heads:—(1) Inorganic—metals, acids, salts, alkalies, etc. (2) Organic—(*a*) acids, alkaloids, sugars, essential oils of vegetable origin, etc.; (*b*) fermentation industry; (*c*) coal-tar distillation products, and (*d*) synthetic organic chemicals, particularly solvents, and the industries dependent upon them. India has good potentialities in most of these branches, but much remains to be done, though in many cases the fringes of the problem pertaining to some solvents, glycerine, sulphuric acid, magnesium sulphate, coal-tar distillates, certain essential oils, and fermentation products have been touched by progressive manufacturers. To give one example, India imports dye-stuffs of coal-tar origin worth about 3 crores of rupees, but only about 60,000 tons of coal-tar are distilled all over India yielding benzene, toluene, phenol, cresol, naphthalenes, anthracene, pyridine, etc. If sufficient supplies of these were forthcoming dye intermediates, *viz.*, aniline, alkylamines, toluidine, etc., could have been easily prepared. If inorganic heavy chemicals, *e.g.*, caustic soda, nitric acid, etc., and organic solvents were simultaneously available, India could produce at least some chemotherapeutic items of urgent need. The position with regard to organic solvents barring alcohol is also very deplorable. Fortunately, attention has already been drawn in this direction, and before long, alkali and bleaching powder industries are likely to be placed on secure foundation in India.

(*ii*) *Glass industry*.—The development of glass industry has a very important bearing on drug industry. The 'container' problem is extremely important. Here considerable progress has already been made, and more is likely to come through the efforts of the Board of Scientific and Industrial Research.

(*iii*) *Toilet and perfumery industry*.—These industries are almost hand-maidens to drug industry and are mutually inter-dependent. Certain amount of success is already evident, but a bright future depends on collateral developments of essential oil industry, glass industry and a general improvement of the economic status and buying power of the community.

(*iv*) *Textile industry*.—For surgical dressings and gauges, etc., cotton and textile industry must provide the requirement. This is already developed in India and no difficulty need be anticipated in this direction.

(B) Other Associated Difficulties:—

(*i*) *Paucity of reliable raw materials*.—One of the chief difficulties which have confronted the manufacturing chemist and pharmacist in India for some time and which is still unsolved is the question of procuring reliable 'raw materials of standard quality'. India possesses vast resources of medicinal plants, but the sources of supply of crude drugs have not been fully explored. There is as yet no reliable organization in India for the collection of drugs in proper manner with adequate arrangements for their drying 'curing' and storing, and later distribution to manufacturing chemists through a regular channel. Except in the case of a few reliable drug dealers, most of the trade in crude drugs is carried through the agency of middlemen who have hardly any botanical or pharmacognostic knowledge of the drugs they deal with. There is no organization such as the 'Bureau of Plant Industry' of Soviet Russia and America, which gives advice and encourages the cultivation of medicinal drugs and takes charge of their distribution to manufacturing centres, through a *central* agency. The result is that the manufacturers are exposed to all sorts of trickeries and frauds in their drug purchases, and unless they can keep well-equipped laboratories for pharmacognostic testing (with resulting increase in the cost of the finished products, they are forced, often without their knowledge) to use low-strength and deteriorated crude drugs.

(*ii*) *Transportation problems*.—This is another difficulty in such a vast country as India, where the sources of raw materials and the factories where they are finally processed are often hundreds of miles away. This adds greatly to the cost of manufacture. In spite of vehement advocacy of the Indian Chemical Manufacturers' Association to institute preferential railway rates for crude drugs and other items used for the preparation of medicines, the situation has not so far been remedied. During pre-war days, Strychnos nux vomica seeds growing in the Mayurbhanj State used to be sold in the London drug market at half the price at which these could be purchased at Calcutta. During the present war, the transportation problem has assumed even

more serious proportions. Apart from the question of railway rates, the question of transport 'priority' has arisen. Crude drugs are not considered on the 'first priority' list, and as such, there is quite often considerable delay in the despatch of crude drugs to the producing factories.

(*iii*) *Excise control.*—Manufacturers and distributors are greatly handicapped due to differences in the Provincial Excise Regulations. While it is not our purpose here to go into the details regarding the intricacies involved in this question, it is important to point out that this is a source of financial loss to many drug manufacturing concerns. The inter-provincial movements of spirituous preparations are beset with difficulties due to excise restrictions which should be removed as soon as possible. Another difficulty is that under the present regulations, all research and analytical works carried out by private manufacturers have to be performed with duty-paid spirits. The same statement holds good in the case of alcohol used for the manufacture of alkaloids and for other extraction purposes. These naturally add to the cost of the finished products issued from the indigenous drug manufacturing houses.

(*iv*) *Lack of machinery and other technological equipments.*—There is at present no department of chemical engineering in this country which can successfully undertake the designing and running of commercial plants suitable for the manufacture of drugs. Part of the difficulty met by manufacturers in increasing production during this war had been due to the difficulty in obtaining even ordinary drug manufacturing equipments, *e.g.*, mixers, stills, dryers, filters, tanks, vacuum pans, refrigerators, autoclaves, incubators, sterilizers, high-speed motors, vacuum dryers, and a host of others required in every-day work. If all these have to be imported from abroad, progress will naturally be hampered. Even if all these were possible to import, the question as to the installation and proper operation of newly imported machinery by Indian technicians would still remain a major difficulty.

Indian Drug Industry needs a New Outlook

There may be many other difficulties of the drug industry which, as a laboratory worker, the writer is not in a position to anticipate. Some of these can be easily remedied by concerted actions, while others will take probably several years and might require State intervention for their successful solution. These difficulties do not, however, appear as insuperable barriers to the development of a virile drug industry in this country.

What the Indian drug industry is now suffering from, at least in the opinion of the writer, is not a *physical* difficulty in her production and developmental problems (which should not, as has been shown, necessarily be ignored), but a *mental* difficulty (using both the words in figurative sense) in its *outlook*. A forward outlook which the Indian drug industry should develop, if it wishes to keep itself abreast of modern times, is that it is predominantly a *public health industry*. Unlike many other industries which cater to the comfort and luxury of the public or to the common utilities of modern civilized existence, drug industry caters to the vital health needs of the nation. It has, consequently, a bigger and nobler responsibility to fulfil. It should, therefore, develop the *binocular* outlook—of an ordinary industry interested in money making, as well as of an industry which is an essential cog in the wheel of the public health machinery of the nation. If this outlook is fostered, many troubles in connection with adulteration of drugs and a spurious drug trade will disappear. Indian drugs would be considered more worthy of use by the Indian doctors, and faith and reliance on Indian products will reign supreme where suspicion and confusion now exist. For future success and for withstanding post-war competition, Indian drug industry must actively carry on their educative propaganda to build the 'Home Front'. It must remember only one slogan—*there are no two qualities in drugs*. A drug is either good or bad and cannot be classified in any other third category. The aim should be to produce only the good quality and to see that the same reaches the consumer in the same quality without being tampered in any way in retail trade and by middlemen.

There is another aspect which appears also to have been missed by the drug industry in this country. Being a product of the two World Wars, Indian drug industry has been thinking only of deficiencies and shortage problems—it has been looking to the 'minus' phase and not to the 'plus' phase of its growth. It has always been trying to produce items which are in shortage and in immediate demand, and for this purpose it has done quite a little up-hill work in the mobilization of capital, equipment and expert personnel from all over the country. It has done a good job for the *present*, but, as is to be expected under the circumstances, it is frankly lacking in that stability and balance which characterizes a well-planned and well-organized peace-time industry. It is already showing many hiatuses in its pattern of growth and so far has not shown any vision for the *future*. Indian drug industry to-day is really a 'developmental drug industry' where only 'drugs of today' are being produced on a copybook basis, but is not a 'creative drug industry' where new agents and 'drugs of to-morrow' for the alleviation of yet incurable diseases can be manufactured. Modern medicine and therapeutics are progressing

rapidly, and an industry which ultimately aims to supply the needs and requirements of such scientific practices can ill afford to be backward and undergo the risk of being wiped out sooner or later. In India, the capitalists and industrialists are largely ignorant of the rôle of science in industry and are apt to think that any expenditure on scientific and research projects are unjustified and unnecessary. Fortunately, this attitude is fast disappearing, and progressive drug manufacturers are increasingly concentrating on research inside their own manufacturing concerns and also promoting researches in Government institutions and university laboratories.

Wanted a National Institute for Drug Research

Piecemeal grants of money and haphazard research projects are not, however, going to solve the most difficult problem of finding new curative agents of the type of urea stibamine of Brahmachari every day. What is needed is a comprehensive long-range programme and planning with a vision for the future. The writer is of the opinion that, in addition to research organizations supported by the industries themselves and the Government institutions that are already existing, there is an urgent need for the establishment of a well-equipped and well-endowed National Institute for Drug Research where a quadrangular collaborative scheme between botany, chemistry, pharmacology and clinical medicine can be fostered. This concept has been elaborated by the writer in his Presidential Address for the Section of Physiology entitled ; "The Scope and Future of Pharmacology in India". If India is not to remain content by manufacturing only the *substitutes* of what has already been done in foreign countries, and if she has to forge ahead in the elaboration of *new* drugs and medicaments for the relief of human suffering, she must come forward with a well-organized policy for the creation of one or more National Institutes for drug research where every facility will be provided for a collaborative effort between the various groups of scientists that are needed in the evaluation and ultimate clinical use of unknown drugs obtained either from the natural sources or as a result of synthesis in the laboratory. Expenditure on drug research is not money lost but will pay a large dividend in years to come, as has been shown from the experience of such firms as the Bayer Co. of Germany, Parke, Davies and Co. of America and the Burroughs, Wellcome and Co. of England.

If the drug industry is developed on sound and ethical lines, there is every reason to hope that it will help India's economic progress by utilizing the raw materials produced in the country, will give stimulus to India's chemical and coal-tar industries, will throw open avenues of employment to a very large number of educated Indian youths and will raise the standard of living generally. State help and protection wherever necessary have been accorded to national drug and chemical industries in all progressive countries of the world, as this is predominantly a public health project and is not just an industry for increasing the wealth of the nation. Drug industry need not worry about State aid. In the new world order which is fast coming after the war, there will automatically be a new outlook on things. It will not then be difficult to realize the need for protection of the drug industry by the State in the same way as a protected water supply, preventive vaccination against small pox, typhoid, dysetery, rabies, yellow fever, etc. These functions have already been taken over by the State. It is only the next step for the State to protect the population from food deficiencies by the manufacture of vitamins and to protect public health by eliminating infectious diseases through proper manufacture and distribution of essential life-saving drugs. Drug industry, seen in this outlook, is really helping in one of the major functions of a modern enlightened State and should receive its major attention and guidance. Sir Ardeshir Dalal may well consider in his 'Policy Committee on Industries' the early establishment of a special 'panel' for drug industry. The time is more than ripe for such a step.

B. Mukerji

COST FACTOR IN THE ELECTRICAL DEVELOPMENT OF INDIA

N. C. SAHA,

ELECTRO-TECHNOLOGY DEPARTMENT, INDIAN INSTITUTE OF SCIENCE, BANGALORE

IN a recent article in Science and Culture (August, 1944), Professor M. N. Saha has rightly stressed the urgent importance of the electrical development of India as the first step towards the industrialization of the country and consequent recovery from the economic stagnation. The object of the present article is to give some idea of the capital expense of a scheme of electrification as well as the price at which a unit of energy may be sold, with a view to promoting greater interest in the above scheme.

Capital Cost

The provision of 100 additional units of energy per head of population annually, as recommended by the National Planning Committee, will be the starting point in the estimation of the capital cost. For reasons stated afterwards, this will first be derived with particular reference to Bengal, from which will be deduced the capital requirement for the electrification of the whole of India.

On the assumption that Bengal has a population of 70 millions, the total number of electrical energy units that has to be supplied is 7000 million per year.

The determination of kw capacity of a plant for the delivery of a given number of energy units per year requires a knowledge of (*a*) Load Factor, (*b*) Efficiency of Transmission, and (*c*) Power Factor of the Load. These can only be estimated from an analogy with similar data available in other countries after due consideration of the local factors that may affect the data.

The load factor* plays by far the most important role in the economics of an electric power plant. A kw plant, for instance, if it delivers its full capacity throughout the year can bring in revenue for 8760 units. On the other hand, if the same plant works at full capacity for 3000 hours during a year or at half its capacity for 6000 hours, on account of the vagaries of load, it can sell only 3000 units. Therefore, to get the maximum benefit out of a given plant, greatest care is to be taken to ensure that the power plant works at near its full capacity for the maximum number of hours.

The following tables give the position of the electrical power industry in general, and of load and

TABLE 1.

Electric Power Industry in Great Britain

Year	Energy generated (million kwh.)	Maxm. demand (million kw)	Plant capacity (million kw.)	Load factor %	Plant factor
1923	5,250	2·05	3·4	29	17·7
1928	9,324	3·37	5·80	31·6	18·3
1933	13,600	4·8	7·85	32	19·8
1938	24,372		8·26		33·5

plant factors in particular, of Great Britain and U.S.A. from 1923 to 1938 at intervals of 5 years.

*Load factor $= \frac{\text{Total energy generated}}{\text{Maximum demand in KW} \times 8760}$

Plant factor $= \frac{\text{Total energy generated}}{\text{Plant capacity in KW} \times 8760}$

Reserve capacity of plant $= \frac{\text{Load factor}}{\text{Plant factor}} - 1.$

TABLE 2.

Electric Power Industry in U. S. A.

Year	Energy Generated (million kwh)	Plant Capacity (million kw)	Plant Factor %
1923	55,665	17·46	38·1
1928	87,850	29·63	35·0
1933	85,402	36·04	27·0
1938	111,498	36·52	35·0

The maximum demand on power plants in U.S.A. is not available, but the load factor of that country can be guessed from the ratio of plant factor to load factor of Great Britain.

In Great Britain and other western countries, the two aspects of the domestic load *e.g.*, lighting and heating, go hand in hand with the result that the domestic load imposes a very severe demand on power supply in winter, but assumes quite a small magnitude in summer. Hence the load factor is inherently poor. In India, on the other hand, the increased lighting load due to the longer hours of darkness in winter is more than offset by the increase in the airconditioning load (refrigerators, fans etc.) in summer. This seasonal uniformity of the domestic load will have a beneficial effect on the load factor. With reasonable development of industry, by the time the electrification schemes come into full operation, a load factor of 33% may not be above the ambit of attainment.

With planned development of the electrical power industry whereby not only generation and distribution but also consumption become an integral part of the scheme of electrification, a much better utilization, and hence much higher load and plant factors, may be attained. In Soviet Russia, for instance, where electrical development has taken place on these lines, the plant factor in 1935 was 45·8% and was steadily increasing.

The transmission efficiency is expected to be in the neighbourood of 80%. For the present rough calculation, the effect of lower power factor on the increase in the capital cost is neglected. Hence the maximum demand on the plant for the supply of 7000 million units is given by:

$$\text{Maximum Demand} = \frac{7000}{0{\cdot}80} \times \frac{1}{8760 \times 0{\cdot}33} = 3{\cdot}0 \text{ million kw.}$$

The cost per kw of installation of a thermal station in Great Britain in 1926 was £15 while that for transmission and distribution was £18 which allowed for final conversion into D.C. current. Hence capital cost of plant, including generation, transmission and distribution, was £33 or about Rs. 440 per kw. Post-war installations which not only in-

corporated normal peace-time progress but also much accelerated technical development during the war period will, it may be expected, cost approximately Rs. 350 per kw of which Rs. 160 may be apportioned to generation and the rest, Rs. 190 to transmission and distribution.

Hence the electrical development of the province of Bengal on the lines suggested by the National Planning Committee will entail a capital expenditure of 105 crores of rupees.

The above estimation is particularly applicable to Bengal where, because of the flatness of the country, super thermal stations and not hydro-electric stations will predominate. The proximity of coal-fields also militates against large scale hydel projects in Bengal. This, however, does not preclude the possibility of development of some of the notorious rivers such as the Damodar and the Tista, but the primary purpose thereof will be flood control, prevention of soil erosion, irrigation, navigation, and control of malaria. Certain amount of electrical energy, of course, may be derived from such schemes.

The fact that thermal stations are more amenable to accurate estimation has induced the author to consider the province of Bengal alone in his calculation of the cost factor. The capital cost of hydro-electric projects which will play a predominant role in other parts of India varies between wide ranges depending on the nature of the scheme. For instance, the hydel scheme for the development of the natural power resources of the Highland of Scotland is estimated to cost £30 million for the output of 450,000 kw (Rs. 900/kw) while a hydel project for the installation of 1,125,000 kw in Canada will cost only £26½ million (Rs. 320/kw). It may, however, be roughly guessed that the execution of the scheme of electrification as recommended by the National Planning Committee *e.g.*, for the supply of 40,000 million units, requires the installation of 20 million kw at a total cost of 1000 crores of rupees.* (This allows a reserve capacity of 17½% on the load factor of 33%—in other words, it allows a plant factor of 29%). Starting practically from void, Soviet Russia attained an output of nearly 40,000 million units in 1937 at the end of the Second Five Year Plan. Cannot India with 2½ times the population of Russia emulate this pioneering enterprise of Russia and reach the same target in the course of the next 10 years?

Price of a unit of electrical energy

While capital cost is mainly a concern of a select few, the price at which a unit of energy may be sold is of paramount importance to every potential consumer. As such, any discussion on the cost factor of the electrical development will be incomplete without a reference to the price at which a unit of energy may be sold.

This thorny problem can only be dealt with from an analogy with data available in the electrically developed countries. The present treatment of the subject is based on the British practice with particular reference to 'Costs and Tariffs in Electricity Supply' by D. J. Botton, Electricity Commissioners' Reports (of Great Britain), and 'Generation, Transmission, and Distribution of Electrical Power' by A. T. Starr.

In the calculation of the capital charge, an interest of 5% has been allowed on the capital outlay and sinking fund. The life of the generating plant (including machinery, land, building) has been fixed at 20 years and that of the transmission and distribution equipment at 30 years. The price of coal is taken to be Rs. 5/- per ton. The following analysis of the cost of unit of electrical energy applies to a super thermal station of 100,000 kw capacity or over with a load factor of 33%.

TABLE 3.

(A) *Cost of generation*		
Cost of fuel at ·5 of coal per unit	·054	As.
Salaries and wages Rs. 4·5/kw	·025	,,
Oil, water, stores, maintenance Rs. 4·5/kw	·025	,,
Management, rates, rent for generation Rs. 5·0/kw	·028	,,
Interest on Capital Rs. 8·0/kw	·045	,,
Depreciation on machinery	·026	,,
Total cost of generation	0·203	
(B) *Cost of distribution*		
Transmission losses	·013	As.
Cost of management Rs. 8·0/kw	·044	,,
Cost of maintenance Rs. 7·0/kw	·038	,,
Rates and rent for distribution Rs. 8·0/kw	0·44	,,
Interest on capital Rs. 9·5/kw	·052	,,
Depreciation on equipment Rs. 2·7/kw	·015	,,
Total cost of distribution	0·206	
(C) *Miscellaneous expenses*	·091	
Average cost per unit	0·5	

The above calculation does not allow for reserve idle capacity of machinery which is essential for continuity of supply, nor does it include profit save 5% interest on capital charge. Accidental damages such as are caused by lightning and fire have also to be provided for. These necessitate the inclusion of ·091 As. per unit as miscellaneous charge which not only covers the above items but also such sundry items as sales expenses. An average charge of 0·5 As. per unit may be taken as a rough approximation of the price that may prevail in India if the electrical development takes place on the lines suggested by the National Planning Committee.

* This presumes a ratio of 3 kw hydel power to 1 kw of thermal power, generation per kw of the former being assumed to cost Rs. 350.

A domestic consumer, because of the uneconomic nature of his load, may have to pay a charge of one anna per unit or even more. A large industrial concern, on the other hand, with a high load factor and a large consumption of energy may pay only 0·25 As. per unit. The tariff must be fixed so as to encourage high load factor of peak energy consumption and a good power factor. In the following table is given a typical tariff for the different categories of

TABLE 4.

Items	Units sold (million kwh)	% of total units sold	Average price (pence per unit)	Revenue
Lighting & Domestic	2306	26·1	3·05	55·1
Public Lighting ..	128	1·6	1·69	1·9
Traction ..	710	9·1	0·88	5·5
Power ..	4927	63·2	0·86	37·5

consumers, that was actually in operation in Great Britain in 1928 when the average price of unit was 1·37 *d.*

The above figures (Table 3) are a sober reminder to many well-intentioned persons who declare that electrical energy may be sold in this country at 0·25 pice or so. Conversion into electric energy requires expensive machinery while efficient distribution, in particular demands a highly technical staff. The interest on the enormous capital expenditure, depreciation on machinery, and salary of staff are the big items which ultimately must be paid by the consumer. It may be seen that fuel accounts for only 15% of the total cost. Indeed it is a striking fact that even if collieries produced coal for nothing and railway companies charged nothing for carrying it, the total reduction in the price per unit which could be effected would be no greater than could be obtained by increasing the assumed load factor from 33 to 39%.

This clearly shows the extreme seriousness of load factor on the cost of the electricity supply. With hydel stations the importance of load factor becomes even more pronounced. In the following table (Table 5) is given the effect of load factor on the price of unit of energy, the various charges being the same as given in Table 3.

These calculations claim to give nothing more than a mere glimpse of the economics of generation, transmission and distribution as may apply to India. Complete details have been purposely ignored with a view to presenting a comprehensive picture of the cost machinery without sacrificing the essential factors.

Concluding Remarks

What, it may be asked, is the justification of a scheme of electrification which entails such huge expense? Briefly, electricity is the life-blood of industry which is the mainstay of the economic structure of a country. Electricity is the power behind the economic regeneration of a backward country, it is the light that can relieve the gloom of national poverty. In fact, as Prof. Saha has aptly pointed out, the prosperity of a nation is directly proportional to the "Energy-Index" *i.e.*, the amount of energy consumption per capita. Any capital outlay in the electrification of India is, therefore, a national asset of the first magnitude.

TABLE 5

Load Factor %	10	20	30	40	50	60	70	80	90	100
Price per unit (As.) ...	1·497	0·782	0·544	0·425	0·353	0·305	0·271	0·246	0·226	0·210

It is highly significant that the Bombay Plan has given first priority to the electrical development of India. Indeed electrification of India cannot but occupy the first place in any programme of economic development of India, which aims at the realization of the national goal of freedom from want.

THE FOOD VALUE OF FISH

K. V. GIRI
DEPARTMENT OF BIOCHEMISTRY, INDIAN INSTITUTE OF SCIENCE, BANGALORE

THE problem of ensuring adequate food supply and production is one of supreme importance at the present moment. In the countries involved in the War considerable interest is being shown in the physical fitness of the population as a whole. This has given a fillip to nutritional studies. It seems desirable at this stage to bring together the most important facts relating to the food value of fish in a concise form for the use of workers interested in food problems. The importance of this is the greater since attempts are now being made in India to formulate a food policy for the production and control of foodstuffs, and for improving nutrition in war, which should be permanently recognised as a part of national policy. This survey of the subject is not intended as an exhaustive treatise of all the work done on the subject. It is proposed to include only that work which is of immediate importance at the present moment, with special reference to India.

Next to agriculture and livestock fisheries constitute the most important industry and source of human food. Great Britain, Japan, United States, France, Russia, Spain, Portugal and Norway are the most important countries in which fish constitutes a valuable food. In Japan and Norway, the marine fisheries occupy a place of considerable importance, because of the very limited extent of cultivated land available for growing enough food for the population. In spite of the small landed area, Japan has a coast line of 20,000 miles in extent. The fishing industry has made rapid strides in recent years and has become a highly important source of economic wealth to the Japanese. It is reported that between the years 1906 and 1933, the number of motor fishing boats in Japan increased from 1 to 45,000. It has been estimated that nearly two million men are engaged in fisheries in Japan. It has successfully tackled the problem of supplying the densely populated country in which the population increased by one-fourth during the years 1912-1927, with enough food by increasing fish production three-fold, a sound policy based on scientific knowledge. In addition to Japan, many other countries, such as Norway, Denmark, Scotland, Newfoundland and Canada have developed fishing industry to a considerable extent.

The need to develop fisheries which is the only prime source of food supply to supplement agriculture, as an important food industry, is greater at the present moment because with the increase in population, there is heavy pressure on land for food crops. As a source of food supply our oceans and rivers would constitute an inexhaustible store of food, provided careful attention is devoted to fish culture. India has a coast line of over 4,000 miles in length surrounding the three sides of the vast peninsula, the Madras coast line alone being 1,750 miles in length. Besides this, there are large rivers such as the Ganges, the Brahmaputra, the Indus, the Kristna, the Godavery and the Cauvery, which contain a large amount of fresh-water fish available for scientific exploitation and for well-planned utilisation.

In India the growth of population is outstripping available food supplies. India's population is increasing at an alarming rate, the present population according to the census of 1941 being 388 millions, an increase of 15 per cent over the last census figure of 338 millions, while the agricultural output of India has remained steady without any significant rise under present conditions. It is reckoned that the total land area of India amounts to about 2·44 acres per head of the population, out of which only about 0·72 acres per head is under food crop, the remaining being under forests and uncultivated and fallow land.* This is indeed quite insufficient to feed the present population. It is, therefore, necessary to explore other sources of food supply in India and fisheries constitute the only important source of food supply to supplement agriculture.

Poor people inhabiting the coastal towns in India consume large quantities of fish in preference to meat because it is a cheaper article of food. Those who cannot afford even the fresh fish consume salted and dried fish which is considerably cheaper than the fresh one. Fish is an important article of foodstuff in Bengal and is taken almost daily by all the classes of the population. They are available throughout the year. Although there are many varieties of fish available for human consumption, a few of them such as Hilsa (*Clupea ilisa*), Ruhee or Rohit (*Labeo rohita*), Katla (*Catla catla*), and Mrigal (*Cirrhina mrigala*) are particularly popular in Bengal, Bihar and Orissa. The important food fish of the Madras and Vizagapatam coasts are Seer (*Scomberomorus*), Sardines (*Clupea*), Horse Mackerel (*Caranx*), Pomfret (*Stromateus*), Jew fish (*Sciaenidae*), Mackerel (*Scomber*), Cat fish (*Arius*), Ribbon fish (*Trichiurus*), Whiting (*Sillago*), Silver Bellies (*Leiognathus* and *Cazza*). The important food fish of the Bombay coastal waters are Halva (*Stromateus niger*), Karli (*Chirocentrus*), Kajura (begti) (*Lates calcarifer*), Ravas (small) (*Polynemus tetractylus*), Ravas (big) (*Scioena bleekeri*),

* The annual report of the Public Health Commissioner with the Govt. of India for 1933.

Mushi (*Scoliodon sorrakewah*), Singnada (*Arius dessumieri*), Toki (vekati) (*Trichiurus savala*), Suramai (*Cybium kuhlii*), Shengti (*Marcones gulio*), Rangoli, Mandeli (*Coilia dessumieri*), Dhumi, Ghol (*Scioena miles*), Wagli (*Dasybatus imbricatus*).

During the last five or six years there has been much investigation in India on the food value of fish. While further investigation is necessary on the food value of fish available in Indian coastal waters, ample data are now available to justify the discussion of their application to practical nutrition work in India.

Chemical Composition

The importance of fish in human nutrition rests primarily on its content of first class animal protein, its richness in phosphorus and its valuable contribution of vitamins A and D. It is mainly the muscular tissue of fish which is consumed as a foodstuff, and therefore all the investigations are mainly concerned with its chemical composition and food value. The chemical composition of fish varies considerably with season and the species.

Fat: The fat content varies widely with the species of fish. Some species of fish store their reserves of fat in different parts of their body, while in others such as the Cod, the liver is the main fat depot, the other tissues being very low in fat content. In the case of other fish like Herring the fat is deposited beneath the skin and between the muscles. Mackerel, Salmon, Herring, Shad and Butterfish are known as fatty fish, while Ood Pollak, Haddock, Whiting and Cusk are lean fish. The fat content of fish varies with season and spawning. It is found that certain types of fish are much fatter in winter than in spring and summer and that they become very lean after spawning. The fat in fish is as easily digested as those of beef muscle and other animal products.

The proteins of fish: Fish is a valuable protein food. It contains about 15—25 per cent of protein. Fish meal is a highly concentrated protein food which can be used for feeding poultry and live stock. The biological value of the proteins of fish meal is found to vary considerably with the type of fish.

Among the Bengal fish, except in the case of Hilsa, the digestibility and the biological value of the fish proteins are very high. The digestibility varies between 83 and 97 per cent, and the biological value between 70 and 88 per cent. The biological value by growth method showed a growth per gram of protein ingested, varying from 1·48 to 1·83 per day. Thus the biological value of fish proteins compare well with the biological value of milk and beef muscle. In general the proteins of fish are as easily digested as those of beef and other animal products.

It has to be remembered that in certain parts of India fish is eaten in conjunction with other foods such as rice, wheat etc. and the proteins of these supplement those of fish and make good any defects in the latter. Fish is a valuable addition to a diet the staple of which is rice. It has been shown that the proteins in fish supplement the growth-promoting effect of pulse proteins (Basu and De, 1938). Thus khesari (*Lathyrus sative*) which does not induce growth in rats when fed at 10 per cent level (Basu, Nath and Mukherjee, 1937) is found to produce appreciable growth when small amount of Ruhee protein is included in the diet. Similarly green gram (*Phaseolus mungo*) and lentil (*Lens esculenta*) which do not promote growth in rats (Basu, Nath and Mukherjee, 1937) induce appreciable growth when mixed with Ruhee fish protein in the proportion 4 : 1 (Basu and De, 1938a). Thus pulse proteins will be utilised more efficiently when they are supplemented with fish in the diet. This is of great practical importance in human dietetics.

The effect of cooking of fish on the utilisation of proteins has received very little consideration from scientific workers. It has been shown that high temperatures have a detrimental effect upon the quality of fish proteins. According to Basu and De (1938a) the proteins of sun-dried meal are more digestible and show a higher biological value than the proteins of the steam-dried meal. Saha (1940) studied the digestion *in vitro* of raw, fried, boiled and partially boiled fish by pepsin, by trypsin and by pepsin followed by trypsin. He found partially boiled fish to be better digested than the other three forms, and concluded, however, that *in vivo* the break down of fish proteins would be fairly complete.

As regards the chemical composition of fish protein it may be said in general that the amino acid make up of the proteins of fish muscle is of the same as those of other animal muscle such as chicken muscle. The proteins of some Indian fish have been analysed (Basu and De, 1938), (Lahiry and Anantakrishnan, 1942). Rosedale (1929, 1930) has determined the diamino acid content of various types of fish which constitute a very important source of food in Singapore.

The mineral content of fish: The mineral content of various species of fish available in Indian coastal waters have been determined by various workers (Bengal fish: Saha and Guha, 1939, 1940, 1941 ; fish from Bombay coastal waters, Niogi *et al*, 1941, Appanna and Devadatta, 1942 ; fish consumed in Bihar, Mitra and Mitra, 1941 ; fish from Waltair coastal waters, Khorana *et al*, 1943 ; Mangalore fish, Health Bulletin No. 23).

VITAMINS

With the development of our knowledge of vitamins and of methods for their determination much work has been carried out on the food value of fish with respect to its vitamin content.

Vitamins A and D: Fish oils constitute important source of vitamins A and D. They form two main classes-- (*a*) fish liver oils and (*b*) fish body oils. The importance of Cod liver oil as a source of vitamin A and D in medical practice is too well known to need special mention. It is not only rich in these vitamins, but also contains in addition certain unsaturated fatty acids which are of great therapeutic value. Its fat is valuable and is easily absorbed. In general the oil content of fish liver (Haddock, Cod, Whiting, Halibut, Tunny, Dog fish, Ling) varies from 50-75 per cent depending on seasonal variations. Good Cod liver contains about 75 per cent of oil. Livers of fish with fatty muscle (*e.g.*, Herring and Salmon) contain small quantities of oil (about 10 per cent).

The vitamin A content is influenced by age, sex, spawning, fishing season, type and location of fishing grounds etc. It is found that if the other factors are nearly equal the vitamin A content of the oil increases with decrease in the oil content of the liver (Higasi, 1940). Thus the liver oils of Herring and Salmon whose livers contain very little oil, yield liver oils of high potency. It is stated that variation in the oil content of the liver is related to spawning. The Cod, for example, ceases to feed during spawning and a large proportion of the oil is transferred to the gonads, the vitamin content being unaffected. The liver oil, therefore, contains higher concentration of vitamin A than when the fish is feeding normally. It is stated that the reverse process takes place during intensive feeding on a diet deficient in vitamin A (Shortland, 1937, 1938).

Small species of fish such as Haddock, Whiting, Plaice etc. contain relatively low proportions of vitamin A than those large species of fish *e.g.*, Tunny, Halibut, Sword fish, Sturgeon and certain sharks, which contain high concentration of vitamin A. Young ones of any particular species are found to be considerably poorer in vitamin A than older ones. In general, however, the different species of fish investigated may be classified roughly as follows according to the potency of the oils:

Haddock, Whiting etc.	..	worthless oils
Cod etc.	..	.. medium oils
Turbot etc.	..	.. good oils
Halibut	..	.. very good oils

Many fish such as Cod and Halibut store large amounts of vitamin A in their liver although they consume food deficient in this vitamin, and the older fish, therefore, contain higher concentrations of vitamin A (Drummond and Hilditch, 1930; Lovern *et al*, 1933; Macpherson, 1933). The potency of Halibut liver oil is found to be related to the oil content of the liver (Bills, Imboden and Wallenmeyer, 1934). It is said that a very large Halibut may contain 90 grams of vitamin A (Lovern, 1942). The cause of such accumulation of large reserves of vitamin A in certain species of fish which eat the same diet as other species of fish whose vitamin A content is considerably less, is quite obscure. It would, however, appear that such species of fish may synthesise vitamin A in the body.

Although liver is considered to be the main storage depot for vitamin A, it is found that in some species of fish, of which Halibut is one, the alimentary tract may contain as much, or even more vitamin A than the liver (Edisbury *et al*, 1938). The viscera (excluding the livers) of Halibut has been found to yield abnormally rich oils. The stomach is practically devoid of vitamin A, while the pyloric caeca and intestines contain very large amounts of the vitamin A. This discovery has led to the commercial production of fish intestinal oils in Canada. The spleen is reported to contain large amount of the vitamin. Herring also contains large quantities of vitamin A in the alimentary tract, particularly in the pyloric caeca (Edisbury *et al* 1938). The body oils of fish contain little or no vitamin A. There are, however, certain body oils of fish such as Sardine, which are equal in potency to cod-liver oil. In general, fish flesh is not a good source of vitamin A. Fatty fish such as Mackerel, Salmon, Herring etc. are found to be richer in vitamin A than are lean fish such as Cod, Haddock etc.

Fish liver oils are, as a class, the most potent of all known natural sources of vitamin D. They are able to store large quantities of vitamin D in their livers. Some of them contain an extraordinarily high content of the vitamin. Although Cod liver oil is a good source of vitamin A, it is not potent enough in vitamin D. Even Halibut liver oil which contains a large proportion of vitamin A is not proportionately rich in vitamin D. Tunny-fish liver contains a large amount of vitamin D, and it provides a new and valuable supply of the vitamin.

As regards the vitamin D content of fish flesh, lean fish (Cod, Haddock etc.) are shown to be devoid of this vitamin, while fatty fish (Herring, Mackerel, Salmon etc.) contain appreciable amounts (300—1700 I.U./100 gr.) of it. Thus lean fish flesh is a very poor source of both vitamin A and D, while fatty fish flesh is a fairly good source of these two vitamins.

Indian fish oils.—In the present war supplies of vitamin A and D for medicinal use have been affected considerably and in order to meet the growing demand for Cod liver oil, research began in India for other species of fish giving liver oils comparable with

Cod liver oil in vitamin potency. The results obtained so far on Indian fish oils are presented in Table I. The investigations have shown that the liver oils from some species of fish, particularly sharks, which infest the Indian ocean are rich natural sources of vitamin A (Madras Fisheries Department, De *et al*,

TABLE I

VITAMIN A AND D CONTENT OF INDIAN FISH LIVER AND BODY OILS

Common Name	Zoological Name	Source	Vitamin A I. U. per gr.	Vitamin D I. U. per gr.
A. *Liver Oils* :				
Air	*Arius arius*	Bengal	200, 650	—
Dhain	*Silonia silundia*	,,	563	6·67
Hilsa	*Clupea ilisa*	,,	120	—
Katla	*Catla Catla*	,,	207	—
,,	,,	,,	583	—
Mrigel	*Cirrhina mrigala*	,,	377	—
Naindal	——	,,	405	—
Ruhee	*Labeo rohita*	,,	622	—
,,	,,	,,	461	—
,,	,,	,,	475	—
Sankhachur	——	,,	387	5·0
Sarputi	*Barbus sarana*	,,	*Nil*	—
Vetki	*Lates calcarifer*	,,	909	—
,,	,,	,,	457	2·8
Ghol	*Scioenia miles*	Bombay	28—32	575
Mushi	*Scioliodon sorrokowah*	,,	7·0—7·4	97
Eagle Ray	*Etobatis guttata*	Madras	1140	—
Gunna Sorrah	——	,,	2200*r*	—
Kanan Kalaru	*Arius thalassinus*	,,	250*r*	—
Pothikelaru	*Arius jello*	,,	*trace*	—
Komban Sura	*Spyrna blonchii*	,,	*50 times as potent as commercial Cod-liver oil*	—
Karakutti	——	,,	351	—
Cat Fish	——	,,	114	—
Manthal	——	,,	494	—
Nethal	——	,,	806	—
Saw Fish	*Pristis perrotteti*	,,	2925	—
,,	,,	,,	——	180-200
,,	,,	,,	8000—12000	—
Shark (hammer-headed)	*Zygœna blochii*	,,	19,760	—
,, (man-eating species)	——	,,	10,750	—
Shark	——	,,	4,331	—
,,	——	,,	450—50,100 (av. 13,600)	—
,,	——	,,	190,000	—
,,	——	,,	——	210-260
Mackerel	——	,,	——	220
	——	,,	——	160
Plough Fish	*Rhyncobatus dieddedsis*	,,	——	250
Sardine	——	,,	246	200
Cod	——	Calicut	2600	—
B. *Body Oils* :				
Chital	*Notopterus Chitala*	Bengal	26	—
Dhain	——	,,	8—10	—
Hilsa	*Clupea ilisa*	,,	0	—
Katla	*Catla catla*	,,	49	—
Koi	*Anabus testudineus*	,,	0	—
Magur	——	,,	*Nil*	—
Mrigel	*Cirrhina mrigel*	,,	90	—
Ruhee	*Labeo rohita*	,,	98- 100	—
,,	,,	,,	109	—
Kurimeen	*Pomadasys maculatum*	Madras	*less than* 2·6	—
Narimeen	*Lates calcarifer*	,,	2·6	—
Neimeen, Palameen, Orace oil Ribbon Fish	——	,,	2·6	—
Sardine	——	,,	2·6—5·2	
Turtle	——	,,	13	
	Barbus dubius	,,	494	—

1938 ; Rajagopal, 1942) and these oils are now being manufactured and have become commercially important. The production of shark liver oil on a commercial scale has proved so successful that nearly 30,000 gallons of oil have been manufactured in the year 1942. The oil is now widely used in Government civil and military hospitals.

The liver oils of some of the species of Bengal fish *e.g.*, Ruhee, Naindal, Katal, Air, Mrigel, and Hilsa are found to contain appreciable amount of vitamin A (Basu *et al*, 1940). The Ruhee, Naindal, Mrigel and Katal liver oils are very good sources of vitamin A, having higher potency of the vitamin than the imported Cod liver oil. The vitamin A potency of some samples of Indian Cod liver oil is found to be about three times more potent than that of the average sample of Norwegian Cod liver oil (De *et al*, 1938). The liver oils of some of the species of Bombay fish, namely Ravas, Ghol, Shengti, Mushi and Halva are found to be several times richer in vitamin A than ordinary Cod liver oil (Niogi *et al*, 1941). Among Indian fish body oils, the oil obtained from *Barbus dubius* is a good source of the vitamin, containing 490 I.U. per gram of the oil.

Although the vitamin A content of some varieties of Indian fish oils is known, very little information is available regarding their vitamin D values. Recently, however, it is reported that the liver oil of Ruhee (*Labeo Rohita*), a variety of fish in Bengal is the most potent source of the vitamin among the others examined. The values on the whole are very small compared to the antirachitic potency of Cod liver oil (Basu and Sen Gupta, 1940) ; Bragaca A. *et al*, 1942) ; Ranganathan (1941) investigated the vitamin D content of fish oils and found that shark liver oils had an average vitamin D content of 210 I.U. per gram, a value about twice that of B.P. Cod liver oil. Among the Bombay fish examined Ghol liver oil is a good source of the vitamin containing 575 I.U. per gram of the oil (Niogi *et al*, 1943). There is a need for further investigation on the vitamin D content of Indian fish liver oils.

Manufacture of fish oils.—The method generally employed for the manufacture of fish liver oils is by blowing low pressure steam into the fresh livers. This process causes the cells to burst with the result the oil is freed from the cells. Various modifications in the process are introduced depending on the grade of the oil required. Cod liver oil which is not intended for medicinal use is prepared by the above crude method. For the preparation of medicinal oils special precautions are taken, such as the selection of good and fresh livers, the use of vacuum boilers so as to render the oil at lower temperature to improve the colour and odour of the oil.

The crude oil thus obtained is refined by removing the stearine which separates after keeping the oil in cold for long period. The oil is then washed with caustic soda, which converts the free acids present in the oil into soaps. These soaps are then removed by washing with water. In order to remove the traces of alkali it is then washed with dilute sulphuric acid solution. The oil thus obtained is bleached by filtering through fuller's earth. The bleaching is also effected by exposing the oil to sunlight.

The vitamin A potency of fish liver oil is influenced by the process of manufacture. It is stated that considerable loss of vitamin A occurs when the oil is heated or cooked in open vessels in contact with air (Robinson, 1938 ; Seshan, 1940). For the preparation of oils with high vitamin potency, it is necessary to minimise the extent of exposure to air, thereby preventing the oxidation taking place.

Hydrogenation and bleaching by treatment with hydrogen or other reducing and oxidising agents are known to cause destruction of the vitamin content of the oil. It is, therefore, necessary to avoid the use of oxidising and reducing agents for bleaching purposes. Bleaching is generally done by treatment with fuller's earth. It is reported that this method of bleaching yields an oil with undesirable keeping quality as a result of the removal of the natural antioxidants of the oil by the fuller's earth.

Properties of the oil.—The medicinal oil is generally light yellow in colour and it should have very slight fishy odour. The acid value and the proportion of volatile fatty acids should be low. The Reichert value should be less than 0·5. The iodine value should not be less than 167. The amount of unsaponifiable matter should be less than 1·5 per cent and higher value is an index of adulteration with mineral oils which are rich in unsaponifiable matter.

With the discovery that Indian Shark liver oil possesses very high vitamin A potency, the Madras Fisheries Department at the instance of the Government considered the question of organising and developing the manufacture of Shark liver oil as a cottage industry in the Presidency in 1937. A scheme for initiating a medicinal oil industry has since been sanctioned by the Government. Medicinal liver oil from the Shark and Saw-fish is now being manufactured in Calicut. The Government of Bombay and the State of Travancore are also manufacturing the oil.

The medicinal value of Shark and Saw-fish liver oil was recognised in India long before vitamins were known and it is stated that fish liver oil industry existed in the Madras Presidency eighty years ago. According to the report on the sea fish and fisheries of India and Burma by Surgeon-Major Francis Day, Inspector General of Fisheries, published in 1873,

in the sixties of the last century there was considerable production of fish oil in the West Coast. It is stated that during the period 1864—71, 3,194,672 lbs. of oil (mainly Sardine oil), valued at Rs. 2,03,829 were exported from Madras alone. Medicinal oil from Shark and Saw-fish was being manufactured and the Shark liver oil was being used both medically and in the leather manufacture. The manufacture of the oil was initiated in 1854 in Calicut and the production amounted to over 5000 lbs. per annum, the price ranging from nine annas to Rs. 1-4-0 per lb. In the year 1870 the cost of imported Cod liver oil fell below that of Indian fish liver oils and consequently the industry suffered a great deal as it could not compete with the imported product. The initiation of the industry in Calicut is only a revival of the flourishing fish liver oil industry in Madras Presidency eighty years ago. Very recently investigations on their therapeutic properties have been carried out. In order to stabilise the industry in India extensive investigations on the extraction, storage, purification and the keeping quality of these oils are necessary because of their high market value.

Stability of vitamin A in fish liver oils.—Fish oils are, in general, highly unsaturated and are therefore very susceptible to oxidative deterioration resulting in the destruction of vitamin A contained in the oils. It is found that the samples of medicinal Cod liver oil show wide variations in their potency ranging from 390 to 1500 International units per gram of the oil. It is, therefore, suggested that from the public health point of view and in the interest of the lay public who are ignorant of the quality of the preparations at the time of buying, the manufacturers should state the potency and the extent to which such preparations can be stored without much loss of the vitamin, particularly in tropical countries like India. There is an urgent need for investigation on the factors such as method of preparation, storage, rancidity etc. influencing stability of vitamin A in Indian fish liver oils.

The development of off-odours and flavours, which decrease the quality of the oils is attributed to the formation of aldehydes, ketones and acids. The percentage of vitamin A oxidised is found to be related to the peroxide value of the oil and the higher the peroxide value the more vitamin A oxidised. With the more unsaturated oils, *e.g.*, Cod, Pollard, the percentage of vitamin A oxidised is found to be smaller at various peroxide values than in the less unsaturated oils *e.g.*, Halibut, Dog fish, at similar peroxide values (Simons *et al*, 1940). It is, therefore, necessary to incorporate substances with fishery products, which have the property of arresting such oxidative changes in the oil.

Antioxidants.—Although a number of substances has been described in the literature possessing the property of retarding oxidative changes in fats and oils, very few of them have been found to be suitable for use in preventing the rancidity in fish oils. In recent years a number of investigations have been carried out with a view to stabilising vitamin A concontained in fish liver oils. Hydroquinone which is known to function as antioxidant for fats and oils has been used to protect the vitamin A in fish liver oils (Holmes *et al*, 1936). Lecithin is found to exert protective action against the oxidative destruction of the vitamin. The combination of the two affords remarkable protection against the oxidative destruction of vitamin A in Halibut liver and Cod liver oils, which is much greater than would be expected from additive effects (Homes *et al* 1936). Lowen *et al* (1937) have tested the antioxidant value of oat flour on Halibut liver and Salmon oils. Oat flour was found to retard the initial peroxide formation, and its effectiveness in retarding rancidity increased as less accelerated conditions of exposure to air were used. Maleic acid has been recommended by the Biological Board of Canada (*Bulletin No. XLVI of the Biological Board of Canada*) as antioxidant for preventing the loss of vitamin A occurring on storage of fish liver oils.

The relation between chemical characteristics, Physical properties and Vitamin Content of Fish Liver Oils

Holmes *et al* (1941) determined the chemical and physical characteristics and vitamin potency of thirty five fish liver and body oils. It was found that the vitamin potency of the Sword fish and Mackerel liver oils increased with increase in the amount of unsaponifiable material. The relation, however, was not entirely consistent. In the case of other oils no consistent relation between any of the chemical or physical properties and their vitamin potency was observed. From the results the authors conclude that it is difficult if not impossible to know the vitamin potency of the oils by determining the chemical and physical properties.

The B Vitamin in Fish

Vitamin B_1.—Relatively little work has been done to determine the vitamin B_1 (thiamine) content of fish muscle. From the results of the few investigations carried out, it may be stated that fish muscle is not a rich source of vitamin B_1 containing only about 0·20—0·40 International units per gram. The liver is somewhat richer in vitamin B_1 the content ranging from 0·4 to 1·8 I.U. per gram. (Fixen and Roscoe, 1937-38, 1940). Fish roe contains more vitamin B_1 than the liver. Some of the Bengal fish (Bhetki, Hilsa, Kholsa, Mrigel, Rohit) contain 10—33 I.U. per 100 grams.

Vitamin B_2 (Riboflavin).—Vitamin B_2 content of fish muscle (Cod, Halibut, Haddock) ranges from 0·05—0·180 mg. per 100 grams (Fixsen and Roscoe, 1940). Recently Billings *et al* (1941) have determined the riboflavin in several Pacific fishes, particularly livers and viscera of Salmon, Tuna, Pilchard and Herring. Fish liver meal is found to be one of the richest natural source of riboflavin, most of the values being between 50—100 γ per gram of moisture and fat free substance. Commercial Pilchard, Salmon and Herring meals were found to contain from 9 to 22 γ per gr. of natural meal. There is need for systematic investigations on the vitamin B_1 and B_2 contents of fish available in Indian coastal waters.

Nicotinic acid (Antipellagra factor).—Among the fish investigated Salmon appears to be a good source of nicotinic acid containing 7 to 8 milligrams of nicotinic acid per 100 grammes of the muscles. Other fish investigated contain on an average 2—5 milligrams per 100 grammes of the muscle. Fish muscle is as good a source of nicotinic acid as beef and the muscle tissue of other animals. (Kodicek, E., 1940 ; Khorana *et al*, 1943).

Vitamin C.—The vitamin C content of fish varies considerably with species containing about 5—200 mg. of the vitamin per 100 gr. Fish liver and roe are found to be rich in this vitamin having the potency of orange juice. Among the Indian fish examined (Rudra, 1936 and Saha, 1939) Koi (*Anabas testudineus*) has the highest ascorbic acid content in the muscle (30 mg. per cent), Pangash (*Pangasius pangasius*) and Rohu coming next in potency. Rohu and Dhain fish livers contain 171 and 127 mg. per 100 gr.

The foregoing account offers ample evidence that fish is a very valuable food and its extensive use on the dietary is, therefore, specially desirable. There is plenty of scope for improving fish food industry in India. Considerable amount of edible fish is being wasted annually and there is ample scope for investigation on the possibility of converting the edible fish into valuable food materials. While it is certain that the potential resource of India is immense in the fish industry, these will become readily available only through well-planned investigation on the economic utilisation of fish products in food and other industries. The need to develop Fisheries as an important food industry in the country was emphasised in the Zoology section of the Jubilee session of the Indian Science Congress in 1938. A committee of foreign and Indian fisheries experts, who met in Calcutta in 1938, pointed out the need for an All-India Institute for research on problems relating to Indian Fisheries and resolved to urge the Government of India to take early steps to develop the fish industry. The fishing industry in India is in a deplorable condition which needs immediate attention with a view to utilising the large potential source of good food to feed the increasing population.

References

1. Appanna, T. C. and Devadatta, S. C., *Current Science, 11*, 333, 1942.
2. Basu, K. P., Nath, M. C. and Mukherjee, *Ind. J. Med. Res., 24*, 1001, 1937.
3. Basu, K. P. and De, *Ind. J. Med. Res., 26*, 177, 1938a.
4. Basu, K. P. and De, *Ind. J. Med. Res., 26*, 191, 1938b.
5. Basu, K. P. and De, *Ind. J. Med. Res., 26*, 197, 1938c.
6. Basu, K. P. and Gupta, K., *J. Ind. Chem. Soc., 60*, 543, 1939.
7. Basu, K. P., Rai Sircar, B. C., and Sen Gupta, J. C., *Ind. J. Med. Res., 27*, 721, 1940.
8. Basu, K. P. and Sen Gupta, J. C., *Ind. J. Med. Res., 27*, 865, 1940.
9. Billings, F. L., Biely, J., Fisher, H. and Hedreen, C., *J. Nutrition, 22*, 425, 1941.
10. Bills, C. E., Imboden, M. and Wallenmeyer, J. C., *J. Biol. Chem., Proc., 105*, 10, 1934.
11. Braganca, B. de M., Ghosh, N. C. and Saha, K. C., *Ann. of Biochem. and Exp. Med., 2*, 133, 1942.
12. De, N. K., Majumdar, B. N. and Sundarajan, A. R., *Ind. J. Med. Res., 26*, 435, 1938.
13. Drummond and Hilditch, *E. M. B. (publication) Report No. 35*, 1930.
14. Edisbury, J. R., Morton, R. A., Simpkins, G. W. and Lovern, J. A., *Biochem. J., 32*, 118, 1938.
15. Fixsen, M. A. B. and Roscoe, M. H., *Nutrition Abst. Rev., 7*, 823, 1937-38; *ibid., 9*, 795, 1940.
16. Higasi, *J. Agr. Chem. Soc., 16*, 1141; *Bull. Agr. Che. Soc. Japan, 16*, 169, 1940.
17. Holmes, H. N., Corbet, R. E. and Hartzler, E. R., *Ind. Eng. Chem., 28*, 133, 1936.
18. Holmes, A. D., Tripp, F. and Statter-field, G. H., *Ind. and Eng. Chem.* (Ind. Edn.), *33*, 944, 1941.
19. Khorana, M. L., Sarma, M. L. and Giri, K. V., *Ind. J. Med. Res., 30*, 315, 1942.
20. Khorana, M. L., Sarma, M. L., Seshagiri Rao, P. and Giri, K. V., *Ind. J. Med. Res., 31*, 25, 1943.
21. Kodicek, E., *Biochem. J., 34*, 712, 724, 1940.
22. Lahiry, N. L. and Anantakrishnan, C. P., *Ann. Biochem. Exp. Med., 2*, 13, 1942.
23. Lovern, J. A., Edisbury, J. R. and Morton, R. A., *Biochem. J., 27*, 1461, 1933.
24. Lovern, J. A., *Chem. and Ind., 61*, 222, 1942.
25. Lowen, L., Anderson, I. and Harrison, R. W., *Ind. and Eng. Chem., 29*, 151, 1937.
26. Macpherson, *Nature, 132*, 26, 1933.
27. Madras Fisheries Department, Administration Report, 1937-38 and 1938-39.
28. Mitra, K. and Mitra, H. C., *Ind. J Med. Res., 29*, 315, 1941.
29. Niogi, S. P., Patwardhan, V. N., Acharya, B. N. and Chitre, R. G., *Ind. J. Med. Res., 29*. 279, 1941.
30. Niyogi, S. P., Patwardhan, V. N. and Acharya, B. N., *Ind. J. Med. Res., 31*, 15, 1943.
31. Rajagopal, K., *Current Science, 11*, 52, 1942.
32. Ranganathan, S., *Ind. J. Med. Res., 29*, 699, 1941.
33. Robinson, F. A., *Biochem. J., 32*, 807, 1938.
34. Rosedale, J. L., *Biochem. J., 23*, 161, 1929.
35. Rudra, M. N., *J. Ind. Chem. Soc., 13*, 740, 1936.
36. Saha, K. C., *J. Ind. Chem. Soc., 16*, 511, 1939.
37. Saha, K. C., *J. Ind. Chem. Soc., 17*, 259, 1940.
38. Saha, K. C. and Guha, B. C., *Ind. J. Med. Res., 26*, 921, 1939; *Ibid., 27*, 873 and 877, 1940; *Idem., 28*, 280, 1941.
39. Seshan, P. K., *Ind. J. Med. Res., 27*, 711, 1940.
40. Shortland, *Nature, 140*, 223, 1937.
41. Shortland, *Biochem. J., 32*, 488, 1938.
42. Simons, E. J., Buxton, L. O. and Colman, H. B., *Ind. Eng. Chem., 32*, 706, 1940.

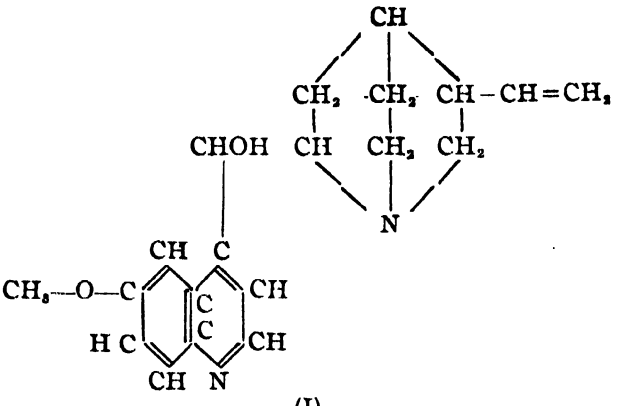
SYNTHESIS OF QUININE

D. CHAKRAVARTI,
DEPARTMENT OF CHEMISTRY, CALCUTTA UNIVERSITY

IN his presidential address before the section of chemistry of the Indian Science Congress, Prof. J. N. Ray, speaking on the chemistry of antimalarials, remarked in 1937, "The organic chemistry of the 'test tube' has very little parallelism with the mechanism operating in the living cells. What molecular species and reagents Nature employs in building up these highly complicated beneficial products has not yet received complete solution in most cases. *The chemistry of the test tube has so far failed to effect a synthesis of quinine and its allies.*"

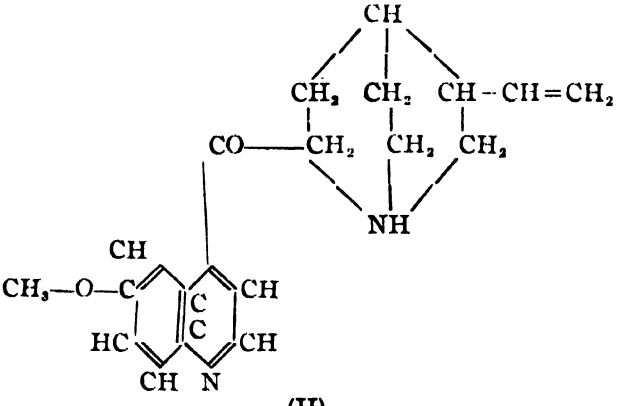
This long-cherished goal, the synthesis of quinine in the laboratory, which has been a challenge to the organic chemists, has at last been attained in 1944 by two young chemists, Robert B. Woodward who is an instructor in organic chemistry at Harvard University and has been chemical consultant to Polaroid Corporation since 1942, and William Von E. Doering who was working at Harvard for the doctorate degree at the time of the inception of the investigation and is at present instructor in organic chemistry at Columbia University. The plan for the synthesis of quinine was conceived by Woodward and incorporated in the basic research programme of Polaroid Corporation in early 1943. This remarkable achievement of Woodward and Doering is the outcome of an organized and planned attack on the problem during 14 months, and the synthesis of quinine was announced on May 7, 1944 by the Polaroid Corporation, Cambridge, Mass. The synthetic quinine is claimed to be identical chemically and clinically with the natural alkaloid isolated from cinchona bark. The synthesis of quinine adds a glorious chapter to the chemistry of synthetics, which can boast of the synthetic vitamins, the synthetic hormones, the synthetic pigments of the flowers and a host of other natural products.

The pure crystalline alkaloid quinine was isolated from cinchona bark as early as 1820. In 1855 Strecker proved the quinine molecule to be composed of twenty atoms of carbon, twenty-four atoms of hydrogen, two atoms of oxygen and two atoms of nitrogen and represented it as having the formula $C_{20}H_{24}O_2N_2$. In 1908 Rabe and Koenigs determined the structure of the quinine molecule and showed by degradative reactions that these forty-eight atoms are arranged in the quinine molecule as in the formula (I). It may be recalled that the preparation of the first synthetic dyestuff *'aniline mauve'*, which gave an impetus to the manufacture of synthetic dyestuffs, is associated with the attempt at synthesis of quinine by William Perkin, a young boy of 18, in the year 1856. Though unsuccessful in his attempt to synthesise quinine, Perkin discovered the beautiful magenta dye by the oxidation of aniline with arsenic acid.



(I)
Quinine

While experimenting with quinine, Louis Pasteur in 1853 obtained from quinine a related isomeric alkaloid having the same 48 atoms, known as *quinotoxine* or *quinicine*, in which the atoms are arranged as in formula (II). In 1918 Rabe was



(II)
Quinotoxine

successful to synthesise quinine from quinotoxine. Since the source of quinotoxine is quinine itself, this synthetic method is of little practical value. Woodward and Doering have been able to prepare quinotoxine from easily available materials, *e.g.*, coal-tar itself, and hence their method constitutes a *total* synthesis of quinine. Starting from benzaldehyde, a common chemical available in unlimited quantities from coal-tar, they have obtained 7-hydroxy-*iso*-quinoline which in its turn has been converted through a series of ingenious synthetic operations

into N-benzoyl-homomeroquinone ethyl ester, the most important stage in these synthetic operations being the fission of the hydrogenated *iso*-quinoline derivative with sodium ethoxide and ethyl nitrite. N-benzoyl-homomeroquinone ethyl ester has been condensed with ethyl quininate to give quinotoxine. The conversion of quinotoxine into quinine has been effected according to the method previously described by Rabe.

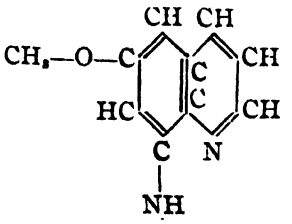
The possible mechanism of the synthesis of quinine in nature, as suggested by Robinson, remains still to be verified. 'It has been thought', as Robinson remarks, 'that plants have at their command enormously powerful reagents, which induce transformations impossible to reproduce in the laboratory. To a certain extent this must be true, but it is probable that this aspect has been exaggerated.'

The long and intricate process of the synthesis of quinine, developed by Woodward and Doering, will probably at present stand in the way of its commercial utilization, but in the near future sustained efforts in this direction might evolve simpler method, and natural quinine may meet with the same fate as natural indigo.

Extensive researches on the preparation of synthetic antimalarials have shown that the physiological action of the quinine molecule depends more or less on the following groups of atoms.

(*i*) The quinoline ring with the methoxyl group ;
(*ii*) The quinoclidine ring ; and
(*iii*) The vinyl group and the secondary alcoholic group.

It has been demonstrated that the removal of any of these groups or alteration in their chemical nature results either in the diminution or the total inhibition of the activity of the drug. Importance has been attached to the quinoline nucleus as being the seat of antimalarial action in the quinine molecule, and a large number of quinoline derivatives have been synthesized and tested for antimalarial activity, the important of them being the much used *Plasmochin*, first introduced by Schuleman, Schoenhoefer and Wingler, the arrangement of atoms in which is shown in formula (III). With a view to



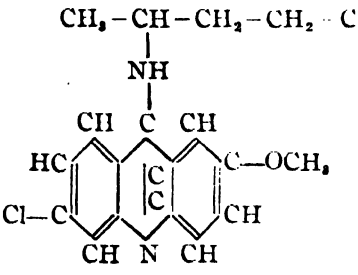
$CH_3-CH-CH_2-CH_2-CH_2-N(C_2H_5)_2$

(III)

Plasmochin

synthesizing an ideal antimalarial, investigations have been carried in the plasmochin series (notably by workers led by Fournean in France, by Magidson and Kritchevskii in Russia and by Robinson and Kermack in England) dealing with the effects of (*i*) modification of the alkoxy group, (*ii*) variation of the alkylamino side-chain particularly regarding its length, degree of branching and the introduction of various other substituents, (*iii*) modification of the terminal dialkylamino group of the side-chain and (*iv*) change in the position of the attachment of the side-chain.

Various acridine derivatives have been studied for their antimalarial activity, and it has been found that *Atebrin* (or *Mepacrin*), first prepared by Mauss and Mietzch, in which the atoms are arranged as in formula (IV), is the most suitable one comparable



(IV)

Atebrin

to plasmochin. In the atebrin series also investigations have been conducted for the discovery of a superior drug by the variation of the atoms and groups of atoms at different positions of the nucleus. The Fourth General Report of the Malaria Commission of the League of Nations summarizes the works on the clinical usage of atebrin and plasmochin, and briefly it might be stated that atebrin is at least as effective as quinine as a schizonticide, though like quinine it has only a weak action on gametocytes, has weak schizonticidal activity and is especially effective as a gametocide.

Alkaloids other than quinine have also been tested for antimalarial activity. In this connection mention might be made of the bark of various species of *Alstonia* which is reputed to possess antimalarial activity, but curiously enough the alkaloids isolated from it have been found to be devoid of antimalarial activity.

Beside these drugs, other synthetic products which bear no structural resemblance to quinine, atebrin and plasmochin, *e.g.*, diamidines, sulphanilamides, cotarnine derivatives, organo-metallic compounds, have also been prepared, and some of them have been found to be partially effective.

Researches in the search for synthetic antimalarials are being vigorously continued. Warner W. Carlson from the Department of Research, in Pure Chemistry, Mellon Institute of Industrial Research, Pittsburgh, Pa, writes in the Journal of the American Pharmaceutical Association (April, 1944).

"Because of the quinine shortage resulting from the loss of the East Indies to the Japanese and more especially because of the inability of quinine, atebrin or plasmochin to act as safe and efficient prophylactics against the disease, the search for superior antimalarial drugs has been intensified since the onset of the war. Under the leadership of the National Research Council and various Governmental agencies, a systematic program of research is in operation involving the co-operation of many chemical and biological laboratories throughout the country. It has been revealed that testing laboratories, each capable of handling as high as 200 new compounds per month, are in operation. The magnitude of the program can be visualized from the report that during the period from 1941-1943, more compounds were tested than the combined total number of all tried in previous efforts."

The production of synthetic quinine at this time has, therefore, been hailed by all, and people all over the world will welcome the synthetic quinine to save them from one of mankind's greatest scourges —malaria.

OBITUARY :

SIR RALPH HOWARD FOWLER

SIR RALPH HOWARD FOWLER was one of the most distinguished and versatile of the mathematical physicists of our times. He was only fifty-five at the time of his death. Fowler's work concerned almost every branch of contemporary physics and whatever he did he did it superably well. A great master of mathematical technique with almost a passionate fondness for details, he revelled in complicated and laborious calculations that would frighten many an accomplished mathematical physicists ; his work informed by profound physical insight was always on a level of rigour characteristic of a pure mathematician. A mathematical physicist of the very first rank, Fowler was a great teacher (he had a large number of students from many countries carrying research under him) and a great man, both in body and in spirits.

Fowler was born on January 17, 1889 at Burnham (Somerset) in England. He received his early education at Winchester and later at Trinity College, Cambridge, where he became a Fellow in 1914. Fowler was in active service during the last war and was wounded at Gallipoli. On his return he joined what later came to be known as the Anti-aircraft Experimental Section of the Munitions Inventions Department where he was associated with A. V. Hill, E. A. Milne and the late W. Hartree (father of Prof. D. R. Hartree) in work on anti-aircraft gunnery and allied problems. After the war Fowler returned to Cambridge.

In December 1921, Fowler married Eileen Mary Rutherford, the only child of the late Lord Rutherford. "Rarely can a man have found a son-in-law so congenial in tastes and outlook. Fowler was a Wykehamist and a Fellow of Trinity. He was a man of great mathematical powers with a firm appreciation of what might be termed the right and wrong in physics, a master in summing up all the experimental evidence and then proceeding to a sound conclusion" (Rutherford by A. S. Eve, p. 288). Mrs. Fowler died suddenly in December, 1930 following the birth of her fourth child. They had four children, two sons and two daughters, the eldest Peter Howard Fowler was born in 1923.

The early work of Fowler was in the field of pure mathematics, and one of his earliest publications was the Cambridge Mathematical Tract on the differential geometry of plane curves. In 1919 Rutherford came from Manchester to Cambridge as the Head of the Cavendish Laboratory, and Cavendish began to hum with radioactive research. The same year Rutherford achieved the artificial disintegration of nitrogen by alpha-particle bombardment, an epochal discovery that marks a landmark in the history of science. (Rutherford commenced this work at the end of his Manchester period and completed it soon after his arrival at Cambridge). About the same time Saha advanced the theory of thermal ionization which provided the key for the elucidation of stellar spectra and which has proved of profound importance in the progress of astrophysics. Rutherford and Bohr had just laid the foundations of modern physics, and Fowler with characteristic energy and versatility entered the various fields of investigation that had opened up. He provided in a joint paper with Aston an exact mathematical theory of the mass spectrograph ; the first mass spectrograph was constructed by Aston two years earlier. He, following the classical theory of Bohr, attacked the problem of the ionization and absorption of alpha rays in matter. To the theory of thermal ionization he, in collaboration with Milne, made many far-reaching contributions.

The ionization theory reduced the sequence of stellar spectral types to a linear temperature sequence. Saha originally suggested that the temperature scale could be deduced on the basis of the *first* and *last* appearances of spectral lines. The difficulties of this method were discussed by Milne, and Fowler and Milne showed that these were largely avoided if, instead of considering the '*marginal appearance*' of a line, attention was directed to the place in the stellar spectral sequence where the line attained its *maximum intensity*. The complete theory of the formation of absorption lines was given later by Milne.

In 1925 Fowler was awarded the Adams Prize for his monograph on the Equilibrium Theory of Statistical Mechanics which, considerably expanded, appeared in book form as "Statistical Mechanics" in 1928. The second edition of this work, revised and enlarged, appeared in 1936. In the first edition, except for the last chapter entitled 'the new statistical mechanics', the language throughout is *classical*, but the second is entirely in quantal dress. The range of topics covered extends over the properties of crystals, dissociation and evaporation, chemical constants—Fowler's discussion of the Nernst Heat Theorem is most illuminating—interatomic forces, liquids and solutions, electrolytes, atmospheric problems, stellar interiors, fluctuations, Brownian motion, and order-disorder phenomena. Everywhere the presentation is systematic, stimulating, precise and profound, employing the elegant and powerful Darwin-Fowler method of 'steepest descents' where sums over accessible states are expressed in terms of contour integrals. The book will remain for a long time to come as the pre-eminent work on the subject. "Statistical Mechanics" has been translated into German. In 1930 there appeared "Statistical Thermodynamics", a joint treatise by Fowler and Guggenhein, being a 'version of statistical mechanics for students of physics and chemistry'. Mention may be made here of the contributions of Fowler, jointly with Nordheim, to the theory of emission of electrons from cold metals under the influence of intense electric fields, and of his beautiful theory of the photoelectric effect. He contributed to the elucidation of the structure of water in a paper with Bernal. What a large field of physics he commanded, and with a grip and penetration seldom equalled!

In 1926 Fowler made the first application of Fermi-Dirac statistics discovered independently by Fermi and Dirac. In a highly suggestive paper he showed how the peculiar difficulty pointed out by Eddington concerning the (possible) ultimate fate of a white dwarf star disappeared when it was realized that under the high density prevailing inside it the free electrons behaved not as a *classical* but as a *Fermi-Dirac degenerate* gas. The high density of a white dwarf can only be explained on the assumption that the material in its interior is completely ionized, but the ionization is not due to temperature but to pressure. Stellar material would be completely ionized whether it is a white dwarf or a 'black dwarf' —a term due to Fowler to designate a 'white dwarf' at zero temperature. As Fowler said at one of his lectures, if one thrust his hand in ionized material, according to Eddington it would always be scalded but according to him it may sometimes be frozen. Fowler's work was the starting point of many investigations. The Fermi-Dirac statistics was incorporated by Milne in his extensive researches on stellar constitution. Milne's fundamental investigation led him to new solutions of the Emden's differential equation which attracted Fowler's attention, and he treated this problem with consummate skill in a paper in the Monthly Notices (1931).

Fowler, jointly with Kapitza, was editor of the International Series of Monographs on Physics (published by the Oxford University Press).

"Fowler had a forceful, even a masterful personality. As I once put it in a sketch of Fowler for the *Granta*, when Fowler was proctor at Cambridge, he had a short way with any committee he was chairman of, and a short way with the chairman of any committee he was a member of. He could be outspoken to the point of inducing tears, but his subsequent contribution was so endearing that he never left bitterness. He was a man who, starting his scientific career in a promising but by no means excessively distinguished way, went on maturing throughout his life, and attained a fame which surprised even his earliest admirers, but which was wholly deserved, and wholly earned. Had he lived, Fowler would have become one of the greatest scientific powers in the land. He had a tremendous capacity for personal friendships ; to collaborate with him on a scientific paper was to embark on high adventure, and the thrill and 'agogness' of working alongside him, when results were being turned out quickly and one was on tip-toes as to what was round the next corner, were things never to be forgotten."*

Fowler was elected Fellow of the Royal Society in 1925 and was awarded the Royal Medal of the Society in 1936. Knighthood was conferred on him in 1942. In 1932 he was appointed Plummer Professor of Mathematical Physics at Cambridge. In 1938 Fowler was offered the Directorship of the National Physical Laboratory but on account of a serious illness he was unable to take up the appointment. For a time he was well but his illness returned, and his many friends in India were grieved

* Quoted from the Obituary Notice by Prof. E. A. Milne in *Nature*, August 19, 1944. We acknowledge the help we have received from it in preparing the present note.

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to learn last winter that his condition was serious. He died on July 28th, 1944.

Fowler achieved much in his lifetime and he inspired all who came in contact with him. There was no trace of pettiness or triviality about him. He was a great mathematician, a great physicist and a great man.

D. K. and *R. M.*

SIR ARTHUR STANLEY EDDINGTON

DURING the period of a year or so, Reuter and other agencies have brought us the sad news of the death of several scientific men of great renown. The latest one of this kind is the rather unexpected news of the death of Sir Arthur Stanley Eddington, the world-renowned Astrophysicist, and the greatest Natural Philosopher of England of the present age. We say *unexpected,* as Sir Arthur was only sixty-two, and was not also known to be ailing beforehand. Even the last number of the *Observatory* which we have received contains an account of his vigorous defense of his Cosmological Theory in a meeting of the Royal Astronomical Society held in June last. Sir Arthur Eddington's name was not only known to specialists, but was also a familiar one among laymen in all countries. To the ordinary man he was the philosopher who spoke about the mysteries of the universe. He (along with Jeans) has brought modern scientific thought almost to the door of every person by his exquisitely written popular books on modern science and astronomy. On this account the death of Sir Arthur Eddington will be mourned by the scientific and the non-scientific world equally.

Of his early life and career we only know that Eddington was born at Kendal on the 28th of December, 1882, and was educated at Owen's College, the nucleus of the present Manchester University, and at Trinity College, Cambridge. He was senior Wrangler (1904), the Smith's Prizeman of the year 1907, and a Fellow of the Trinity College, Cambridge. He started his career as Chief Assistant at the Royal Observatory at Greenwich in 1906, where he continued till 1913. In the same year he was called to Cambridge as the Plumian Professor of Astronomy, and in 1914 he became the Director of the Cambridge Observatory. He worked in these capacities till his death.

Eddington was a member of many British and foreign scientific societies and was awarded the Hopkins Prize of the Cambridge Philosophical Society (1918-21), the gold medal of the Royal Astronomical Society (1924), the Bruce medal of the Astronomical Society of the Pacific (1924), and the Henry Draper Medal of the National Academy of Sciences. He was knighted in 1930.

To recapitulate the entire work done by Eddington is not an easy affair. Nearly the whole domain of theoretical astrophysics was the field of his researches, and every branch of this science bears the impress of his Roman hand. In 1919 he led the Solar Expedition to test if the straight path of a ray of light sent out by a star is curved while passing the neighbourhood of a massive body like the Sun, as was predicted by Einstein. The announcement of the positive result which he found rang through the world as a discovery of profound significance, and at once brought Einstein's Generalized Theory of Relativity to fame. Since then Eddington became one of the staunchest supporters of Generalized Relativity, and swang to and fro between Relativity and Astrophysics, earnestly discussing problems in both these subjects.

Eddington's *debut* in scientific life was made by his analysis of the *double star streams.* At the beginning of the present century our knowledge of the stellar world, and of the Milky Way was rather meagre. Astronomers were indeed only collecting data for their attack on the problem of the universe. Stars in the sky were long known to have motion in space. It was originally believed that these motions were entirely random, just like the motion of gas molecules. The Dutch astronomer, Kapteyn, from a deep study of stellar motions, suggested that the stars have a general motion, and there are two fixed directions in which the stars are streaming. Thus the stellar motion may be considered as a general motion along these streams, plus a haphazard motion like that of the molecules of a gas. Eddington analyzed this double stream mathematically. His researches in this line are embodied in his book 'Stellar Movement and Structure of the Universe', which was published in 1914. This pioneer work helped the construction of the present theory of Shapley, Oort and Lindbland, according to which the so-called Milky Way is a spiral nebula about 100,000 light years broad, and about 10,000 light years in thickness, rotating about an axis directed towards the star cloud of Sagittarius. Indeed this hypothesis makes the phenomena of star streams easily comprehensible.

The theory of the internal constitution of stars, as we understand it at present, is a creation of Eddington. The equilibrium of gas spheres was previously discussed by Ritter, Lane, and very fully by Emden. Emden has incorporated his researches in his *'Gaskugeln'*, which is classic in astrophysical literature. But in all these previous discussions there was no attempt to correlate the results of mathe-

matical investigation with observational material. The real contribution of Eddington to this problem was twofold. He first realized clearly by bringing in his calculations the part which the pressure of radiation plays in this problem. In the interior of a gas mass the pressure at any point firstly is exerted by the gas itself. But owing to the intense heat the stellar bodies hold a huge amount of radiation, in all forms from heat to X'ray vibrations, pent up within themselves. This radiation also exerts a pressure in the same way as light exerts pressure, a fact which was first mathematically worked out by Maxwell, and later experimentally verified by Lebedew. This combined gas and radiation pressure in any part of the gas mass has to contend against the weight of this mass to keep the whole material in equilibrium. The next question which Eddington had to answer was "how does the pent up radiant energy flow outwards"? Realising the fact that under stellar conditions the energy flows mainly by radiation and not by the usual processes of conduction and convection, Eddington first worked out the equation of Radiative Transfer of Energy in the equilibrium state which obtains in stars. His mathematical theory enabled him to deduce in 1924 a relation between mass and luminosity of stars, which has been entirely supported by observational results. This is known as Mass-Luminosity relation in astrophysical literature. From this it is possible to predict approximately the mass of a star when its luminosity has been measured. Earlier in 1920 Eddington calculated from his theory the diameter of the giant star Betelgeuse. Michaelsam and Pease in the same year succeeded in measuring by interferometer diameter of this star, and their measurement was in agreement with Eddington's calculation. Eddington's investigations of stellar structure landed him in a difficulty of fundamental nature. He deduced a numerical value for the degree of opaqueness called "opacity" of the star Capella by combining the results of his mathematically investigations with observational results, which disagreed with the value deduced from purely physical theories by a factor 10. This indeed led the way for further progress. Eddington himself showed that this discrepancy would disappear if the stars were supposed to be made predominantly of hydrogen. The astrophysicists now believe this suggestion to be correct, and all work at the present time in this line is made under this assumption. The recent theory of energy generation in stars by Bethe also supports this idea of the abudance of hydrogen in stellar material.

In his study of the internal constitution of stars Eddington came to the conclusion that the atoms within the star are stripped of almost all of their electrons, and move about almost naked devoid of their outer coverings of electrons. This reduces the size of the atoms enormously, so that the stellar material should be capable of showing extremely high compressibility. Are there really stars in the sky which support this idea by possessing transcendently high density? Sirius, the brightest star in the sky has a dark companion (of very low luminosity) which was found to have the size of Uranus, but a mass nearly equal to that of the Sun. For these data the density of the companion of Sirius works out to about a ton to a cubic inch. Under terrestrial conditions this is an absurdity, but Eddington gave the correct explanation for the existence of such high densities in stars known as *white dwarfs*. He further predicted that the spectral lines of this star should show a red-shift according to the principles of Generalized Relativity. This prediction was indeed later verified by Adams. The theory of dense matter in stars, technically called matter in degenerate state, has subsequently been worked out in fuller details by many workers amongst whom are three Indian astrophysicists Chandrasekhar, Kothari and Majumdar.

The heat and light we receive from the Sun and the stars directly come from their outer envelope. In the case of the Sun it is called the *photosphere*. The radiation from the deep interior of the Sun slowly finds its way into the photosphere in which, specially in its upper part, the characteristic dark line spectrum of the Sun known as Fraunhofer lines is formed. Here in the photosphere we have a flow of heat and light energy of a definite amount which can be measured, from which atoms suspended in the envelope at different heights absorb light of certain frequencies, and give rise to the dark Fraunhofer lines on the otherwise bright background. The astrophysical problem is to explain the intensity distribution in the lines and in the background. Eddington worked at this problem and has made substantial contributions towards its solution.

A class of stars known as Cepheid variables present one of the most intriguing problems of physical astronomy. These are stars which change in brightness periodically. The brightness first increases rapidly, then slowly decreases, and a whole cycle is completed in a time between six hours to about six days approximately. Similar phenomena known before were explained as eclipsing of the main star by a much less bright companion revolving round it. The astronomer Shapley first proposed after a study of the phenomena that the Cepheid stars are of a different kind, and their periodicities in brightness are produced by the pulsations of the stars themselves. At this stage Eddington took up this problem and gave the mathematical theory of the adiabatic pulsations of stars. The problem of Cepheid variables is still awaiting solution, but Eddington has been at it continuously, and his last papers on the subject were

published in the Monthly Notices of the Royal Astronomical Society in 1941.

It must not be supposed that Eddington's work in different fields always led to unique conclusions which were universally acceptable. A large amount of the work was of speculative nature and give rise to heated controversies. Views diametrically opposite to his own are held by many astrophysicists on many issues. But it may safely be said that Eddington's speculations and the attendant controversies have generally led the way to our better understanding of the stellar phenomena.

We have already remarked on the part played by Eddington in spreading the doctrine of Generalized Relativity in the English-speaking countries. The internal beauty of the theory and the observational confirmations it received from time to time brought complete conviction in the mind of Eddington about the correctness of the theory, so much so that it entirely determined his subsequent outlook regarding the universe and the cosmos. He was a firm believer in Lemaitre's Cosmology, popularly known as the theory of the Expanding Universe, which he himself developed considerably. In a recent modification of of his cosmological theory Eddington has put down the time scale for the evolution of the universe at something less than 9×10^9 years, and remarks, "I do not see much prospect of evading this limit". The writer has an experience of Eddington's unbounded enthusiasm for relativity. In December 1937, Eddington came out to India with other British scientists on the occasion of the Jubilee Celebration of the Indian Science Congress. Eddington was the guest of Prof. Saha at Allahabad for a couple of days. It was arranged that he should motor from Allahabad to Benares and join the main group of British scientists who were then taking a hurried tour through India. After a crowded programme over two days at Allahabad, Prof. Eddington accompanied by Saha and the writer started for Benares in a car. Saha whispered to the writer in Bengali "we must not talk but give the old man some rest". We tried to be discreet, but soon discovered we were mistaken. The "old man" was never tired of talking Relativity. In fact, we had a most stimulating discussion on Relativity and Cosmology for over an hour and a half in the car while the corn fields of that flat country were flying on both sides of us.

Eddington did not stop with the Relativity theory of the gravitational phenomena. He endeavoured to extend it to the theory of electrons and protons. His latest idea was the square of the ratio of the electric and gravitational forces between the electron and the proton is of the order of the number of particles in the universe, which he put down at about 10^{79}. His theory aims at obtaining relations between the fundamental physical constants, such as the ratio of the masses of the electron and the proton (given by a root of a quadratic equation), or definition of the range of nuclear forces (given by $k = R_0/\sqrt{N}$, where R_0 is the radius of the Einstein Universe, N the number of particles in the universe, and k defines the potential of nuclear forces e^{-r^2/k^2}), and quantities of this kind. These speculations have not received support from the contemporary physicists and astronomers. But it must be admitted that a complete cosmological theory should in addition to a full description of the existing state of affairs also make attempts to pry into the mysteries of the universal physical constants and the relations amongst them, to which our attention has also been drawn by Dirac. Eddington attempted to arrive at conclusions regarding these questions by his own method. His views regarding his own attempt at a unitary theory of the physical world cannot be better expressed than by his own words as follows "A *unified* theory does not necessarily mean a *unified formula*". The latter kind of unification is exemplified by the theory of the "Generalized Astronomical Instrument", which combines in a single equation the theory of the altazimuth, meridian circle, prime vertical instrument, equatorial, and almucantor. We do not aim at producing a formula which shall include simultaneously the irregular gravitational fields of general relativity and the quantized energy of an atom. We seek instead the common meeting point from which the specialized developments and approximations appropriate to the gravitational and the atomic problem branch off (Relativity theory of protons and electrons).

For his grand attempt at a complete understanding of the universe we should call Eddington a philosopher. But his contribution to positive knowledge is not in any way meagre. By his "analytical boring machine" he has opened up the bowels of the stars, from which we have gained definite knowledge about their interior in several respects. He has raised mere speculations into the higher rank of mathematical theories through which contact with observational data has been made possible. He has disseminated the knowledge of the physical world which modern science has gained, among ordinary men through his charming English style and refreshing humour. He has also raised storms of controversies which when they blow over will clear up our horizon and enable us to see better the brilliance of his work, and appreciate what addition he has made to our knowledge.

N. R. Sen

Notes and News

FERTILIZER MISSION'S REPORT

THE Technical Mission headed by Mr G. S. Gowing of the Imperial Chemical Industries Ltd., which was appointed by the Government of India to investigate, and report on, the technical problems involved in the manufacture of ammonium sulphate in British India in quantities up to 350,000 tons per annum, has now submitted its final report. The Mission recommends that the establishment of a single factory, with a capacity of turning out 350,000 tons of ammonium sulphate annually, at a capital cost of 10·1 crores of rupees in Harduagunj near Aligarh in the United Provinces will be the most economic so far as their findings go. The cost of production per ton of the manufactured product from such single plant would be Rs. 114/- at factory and Rs. 126/- at the distributing centre on an approximate calculation.

The possibilities of setting up more than one factory have also been investigated, but the report shows that the larger the number of producing centres with smaller plant capacities, the greater will be the cost of manufacture, both capital and recurring. Thus, for two synthetic fertilizer factories, one near Aligarh with a production capacity of 250,000 tons and the other in the Cauveri area with 100,000 tons capacity, the capital cost is estimated at Rs. 12·7 crores and the manufacturing cost per ton at Rs. 127/- at factory and Rs. 135/- at the distributing centre. The establishment of three factories at three different places such as Dhanbad, Aligarh and Trichy, each having an output capacity of about 116,700 tons per annum, would involve a capital expenditure of about Rs. 15·7 crores and make available ammonium sulphate at Rs. 139/- per ton at factory and at Rs. 144/- at the distributing centre. For six factories in six different centres such as Dhanbad, Moghalsarai, Amritsar, Bombay, Trichy and Bezwada, five having a production capacity of 50,000 tons each and one with a capacity of 100,000 tons, the capital cost is likely to run to a figure as high as Rs. 21/- crores, and the cost of ammonium sulphate per ton is estimated at about Rs. 167/-. These considerations have led the Mission to recommend centralized production of synthetic fertilizer through one single factory to be located at Harduagunj near Aligarh, which is considered as the best site.

After due consideration of the raw materials necessary for the manufacture of ammonium sulphate and at the same time available in India in abundance, the Mission concludes that the most economic process would consist in the production of ammonia from water gas made from coke and its subsequent conversion to ammonium sulphate by treatment with gypsum. The required coke will have to be obtained from Bihar and gypsum or anhydrite from Khewra in the Punjab. In view of India's limited reserve of coking coal, the Mission has suggested that the possibilities of utilizing non-coking coal for the production of water-gas should be fully investigated. The use of charcoal in place of coke has been discouraged, as its use, in the Mission's opinion, does not offer any advantage. Anhydrite, however, can be used in preference to gypsum, provided it is available in adequate supply, and for this a thorough survey of the Punjab Salt Range should be undertaken. If such a supply be not ensured, production of gypsum in Rajputana should be developed as a second source.

Granting that decision will be reached in favour of setting up a single factory, the Mission calculates that the allocation of capital expenditure between India and abroad will be Rs. 6·0 crores and Rs. 4·1 crores respectively. We are given to understand that the fullest use will be made of raw materials and labour available in India. Structural steel work and buildings, mild steel, construction work such as tanks, vessels, low pressure gas and air mains, gas holders and purifiers, cranes, cast iron water mains, cast iron tanks and vessels, a proportion of the mechanical equipment and refractory materials can be obtained in India.

As the Mission was primarily concerned with the manufacture of ammonium sulphate, it has not calculated the capital and operating cost of alternative nitrogenous fertilizer, such as ammonium nitrate. It has, however, stated that the production of ammonium nitrate will be definitely cheaper and that work should be instituted to determine the suitability of ammonium nitrate as fertilizer under Indian conditions. With regard to the question of technical personnel needed in the industry, the Mission recommends that a number of Indian chemists and engineers with good university qualifications and sound experience in some of the chemical works or ordnance factories in India should be sent overseas for training. Initially, the Mission suggests, the erection of the plant will be the responsibility of a main contractor who will be under obligation to provide a number of technicians. The training of Indian nationals who will ultimately

assume control of the plant will be best carried out by allowing them to be on the site to watch the erection of the plant.

THE UNIVERSAL DECIMAL CLASSIFICATION FOR LIBRARIES

We learn from a report in a recent issue of *Science* that the British Standards Institution has undertaken to publish a number of volumes on the Universal Decimal Classification for Libraries, of which the first four completed volumes have already appeared. This work presents a system for classifying library books, that can be applied to special subject libraries, as well as to general libraries all over the world. The elimination of language and its replacement by numbers have made possible the use of a library of any country by a librarian of any nationality with perfect ease and freedom.

The Universal Decimal Classification is, in fact, the improved and enlarged version of the Dewey Decimal system developed along somewhat the same principles. This classification was prepared by the Federation International de Documentation with the help of leading experts in many fields. The International Federation of the National Standardizing Associations adopted it for the classification of its documents. The present English edition of the Universal Decimal Classification followed the request of both the British Society for International Bibliography and the Association of Special Libraries and Information Bureau. French and German editions, however, appeared before. An abridged system formed by the major groups with simpler symbolic representation, which can be advantageously used for the classification of books in smaller libraries, is also available.

The Universal Decimal Classification, as is expected, is under the continual supervision of experts seeking to keep it up-to-date. The Commission and Secretariat of the classification of the Hague has the final decision for amendments and extensions. The classification is highly useful to experts and libraries in specialized fields owing to its detail and flexibility to accommodate an indefinite number of subdivisions. It is also well adapted for use in connection with various automatic card sorting machines.

SOVIET OBSERVATORIES UNDER GERMAN HANDS

Curiosity centres round the fate of observatories and scientific institutes of U.S.S.R., while under German hands, now that the German occupied territories of Soviet Russia have been liberated by the Red Army. *Nature* has recently published notes on the looting of Simeis Observatory in Crimea and the gallant saving of the valuable library of Pulkovo Observatory, now a heap of ruins, which make interesting reading. Before the German occupation of the southern part of Crimea, the staff of the Simeis Observatory could carry with them the object glasses of the two astrographs and part of the laboratory equipment during evacuation. In May 1944, after the liberation of Crimea, Dr Shajn was sent by the Academy of Sciences to inspect, and report on, the remains of the Observatory. The investigations of Dr Shajn reveal that during September and October, 1943, German specialists dismantled all the Observatory's instruments and dispatched them first to Simferopol and thence to Germany. The instruments so removed include the 40-in reflecting telescope, the double astrograph, a new astrograph for zonal observations, a photo-heliograph, three steel spectrographs, a large coelostat, a long-screw measuring machine, a Repsold machine, a microphotometer and two astronomical clocks. Besides, the whole library collection of more than nine thousand negatives and the equipment of the power station and workshop were carried away. The wooden parts of the three Observatory domes, the wooden building which housed the spectro-helioscope and a number of other pavilions were destroyed. The main building of the Observatory caught fire on January 18, 1944, and nothing was done to bring it under control. This is another instance of Nazi vandalism in which the Germans have specially indulged in this war whenever there has been an opportunity.

The destruction of the valuable library of the Pulkovo Observatory was generally assumed when the Germans destroyed it in 1941 (SCIENCE AND CULTURE, Vol. 7, No. 12). This library contained many rare treasures, including the manuscripts of Kepler. According to an information of the *Moscow News*, it is learnt that the library has escaped destruction. The library was stored away in the basement of the building, and after the Germans shelled the Observatory for three weeks, decision was taken to save the library at any cost. The employees of the Leningrad Musuems and Park Administration who undertook to remove the library worked under incessant artillery fire in the middle of October, 1941, until all the books were removed to a safer place. The act represents a heroic effort of the highest order that has ever been made to preserve the culture and civilization of men, accumulating through ages.

THE 1945 ART IN INDUSTRY EXHIBITION

The fifth annual Art in Industry Exhibition will be held in Bombay at the J.J. School of Art early this year. The prospectus of the 1945 Exhibition, just issued, indicates that this year's exhibition is going to be far wider in scope than its predecessors. The exhibition will include sections

devoted to commercial photography, typography, handicrafts, interior decoration and all types of commercial art. The Outstanding Production section, a successful feature of the last exhibition, has also been included and proposes to show the best of India's wares judged from the criterion of pleasing appearance. The exhibits of this section will comprise the best furniture, cloths, glassware, pottery, printing, etc. The prize money allotted for this year totals Rs. 25,000/- and is reported to be the largest sum ever offered to artists and art students in any single exhibition in India.

We further learn with satisfaction that the proposed Indian Institute of Art in Industry will be registered this year and will take over control of the movement after the next exhibition. The Institute will be an All-India body with membership extending from the Central Government right down to students, the latter requiring to pay Rs. 5/- per annum. There are classes of membership for every type of firm, body or individual. The Institute further proposes to undertake educational work, bring out many publications concerned with applied art, and help India's industrial progress in many directions as soon as funds are available and conditions return to normal.

We have always advocated the importance of Art in Industry movement and are glad to note the steady expansion of the exhibition, first conceived and organized by the Burmah-Shell. The success of the 1944 exhibition, we are told, led the Information and Broadcasting Department, Government of India, to send to England the 300 best entries for display in London by the High Commissioner for India, which were highly appreciated. The fact that the organizers of the exhibition have found it possible to bring into existence the Indian Institute of Art in Industry within so short a period is a clear indication of the need of a like institute and of the deep appreciation of the movement on the part of Indian industrialists, and we entertain no doubt as to the significant role the Institute is destined to play in the industrial life of future India.

STORM OVER SUNSHINE D

UNDER this heading *Time* (30-10-44) has given an account of the intervention by the antitrust division of the U. S. A. Justice Department in a recent patent infringement suit brought by the Wisconsin Alumni Research Foundation.

The history of the starting of this Foundation is very interesting. Dr Harry Steenbock, the famous biochemist of the Wisconsin University, discovered a method of enriching the vitamin D content of many food products by irradiating them with ultraviolet light from a quartz mercury vapour lamp. This method is based upon the discovery that these food products contained 'provitamins' which could be activated by ultraviolet radiation contained either in the sun's rays or by artificial means. In order to avoid unscrupulous commercialization of his discovery, Dr Steenbock decided to let the University utilize his patent and use the profit for research.

Nine alumni of Wisconsin started the Foundation in 1925, which has no direct connection with the University. In all, the Foundation has accumulated $9,000,000 which will eventually go to the University. So far the University has received $2,500,000. Dr Steenbock gets out of this only his usual salary of $12,000. None of the Foundation members, each of whom subscribed $100, nor any of the subsequent members have received anything out of this fund. The President of the Foundation, George Height, a well known Chicago patent lawyer, also gets nothing.

The change brought by the antitrust department against the Foundation is that it has conspired with 16 companies to suppress competition in the manufacture and sale of vitamin D. They are also charged with limiting the potency of vitamin D used in the widely advertised 'enriched' bread, milk and other foods, thus preventing such foods from competing with regular vitamin D products. It is stated that the cost of making vitamin D that sells for from $3·35 to $10·80 is 15 cents. The high prices charged are said to prevent the very people whose need of vitamin D is the most acute from obtaining it. This case brings up the very interesting problem of the ethics of profit making, when such profits are utilized for public utility purposes like the support of university research.

THE 27TH ANNIVERSARY OF THE BOSE INSTITUTE

THE 27th anniversary meeting of the Bose Institute took place on the 30th November, 1944, when the sixth Sir J. C. Bose Memorial Lecture on 'The Evolution of Life Form' in plants was delivered by Dr K. P. Biswas, Superintendent, Royal Botanical Gardens, Calcutta. The Director's report presented to the meeting describes the principal investigations undertaken in the Institute last year. We give a short summary of the report.

Sir J. C. Bose's investigations on motor organ of plants like Mimosa, Desmodium, etc. are being continued with a view to elucidating the biochemical processes underlying the motility of different plant organs. The energy of the pulsatory movement of the leaflets of Desmodium gyrans has been shown to be due to photosynthetically produced carbohydrates in the leaflets. The respiration of the leaflets under favourable conditions shows the same periodicity as their mechanical pulsations. Effects

on respiratory activities of co-enzymes like thiamin, nicotinic acid when added to various substrates like glucose, sodium salts of pyruvic, citric, malic acids have shown that the addition of a minute trace of indole-acetic acid increases by fifty per cent. the respiration in Desmodium leaflets with sodium malate as substrate, indicating that the fundamental function of the auxins in cellular metabolism is of a respiratory catalyst. Bose had already found that in the pulvini of these motor plants an active substance is present which, by microchemical tests, was identified as an unsaturated carbon compound which is neither a fat nor a lipoid. This substance has now been identified as a carotenoid of the crocetin group, which has been recently found by Moewus, Kuhn *et al* to be responsible for the motility of the flagella of *Chlamydomonas cugamatos*, and for its sex behaviour.

Cosmic ray investigations using photographic plates and Wilson chamber have led to a new method of determining the mass of meson and of its energy spectrum in cosmic rays. The mean life time of the spontaneous fission of the uranium nucleus has been determined by two independent methods, and it is found to occur one million times faster than the rate calculated by Bohr and Wheeler.

Photographs of nuclear fission and burst due to cosmic rays produced in the gaseous volume of a Wilson chamber have been obtained. *Applied investigations* deal with the production of new mutants in jute resulting from treatment of jute seeds to X-rays, γ rays and neutrons. Some of the mutants have desirable characters of economic importance. Breeding by selection and hybridization of cotton with a view to the evolving of long stapled disease resistant types is being carried out successfully. Retting of jute and other fibres by means of the enzyme Hiparol secreted by certain moulds and bacteria is being investigated with a view to devising an economic method of retting fibres under uniformly controllable conditions. Comparative studies on the production of butanol and acetone by moulds and bacteria are being carried out. Production and isolation of bacteriostatic substances like Penicillin from different species of moulds are being successfully investigated. The fungal infection of rice by Helminthosporium and methods of combating it have been studied. Fungal infection of tropical fruits are being studied from a similar point of view. Production of food and medicinal yeast and the breeding of suitable yeast strains by selection and hybridization are being worked out. Vernalization of rice for the production of early ripening varieties, propagation of potatoes from isolated 'eyes' are being investigated. The period of viability of stored 'eyes' is under investigation.

ELECTRICAL CONDUCTIVITY OF METALS

PROF. K. S. KRISHNAN, D.Sc., F.R.S., delivered his Ripon Professorship Lectures at the Indian Association for the Cultivation of Science in the last week of November. In course of four highly illuminating lectures, he explained the wave-mechanical theory of the electrical conductivity of metals from a new standpoint. The intensity of scattering of an electron beam by a metallic single crystal may be obtained by an extension of the method adopted by Einstein and Smoluschowski for the intensity of scattering of light by liquids. The method is readily applicable to the case of order-disorder alloys where the scattering resolves into two parts, (1) due to density fluctuation, (2) due to fluctuation in the relative concentrations of the atoms of the two constituents. The theory was shown to explain a large number of electrical properties of order-disorder alloys, so far unexplained. The lectures will be published in the form a memoir by the Association.

THE INDIAN DRUGS RESEARCH ASSOCIATION, POONA

WE welcome the recent formation of the Indian Drugs Research Association in Poona, a research organization which seeks to carry on investigations about Indian drugs from scientific and national point of view. The aims and objects of the Association include, among others, the following: attainment of self-sufficiency in the matter of medicinal drugs in India; collection and cultivation of all knowledge about Indian drugs, which term shall include drugs of mineral, vegetable or animal origin, natural to, or available in, India; undertaking of biological, chemical, pharmacological, pharmaceutical, clinical and other scientific investigations required and making all kinds of provision to that effect; collection and cultivation of medicinal plants in a museum and garden to be maintained for that purpose; maintenance of laboratories, hospital and a library; publication of papers and pamphlets and arrangement for discussions, lectures and conferences; co-operation with individuals and institutions interested in the Association's work etc.

It will take some time before the Association can have its own equipment and staff. But it has already succeeded in enlisting the active support of various experts and in securing facilities for investigations in the existing laboratories.

BASIC CHEMICAL INDUSTRIES IN INDIA

DR H. GHOSH, while delivering his presidential address at the 6th Annual General Meeting of the Indian Chemical Manufacturers Association held in Calcutta on December 8, 1944, made a special plea for the development of basic chemical industries in

India. He drew attention to the production of ammonia, cheap nitric acid and hydrogen, calcium carbide, urea, solvent, bye-products of coal tar industry etc. He laid special emphasis on the development of a powerful coal and coal tar distillation industry for which abundant raw materials exist and on which depends greatly the development of fine chemical and pharmaceutical industry. Referring to the Government's decision to establish the synthetic fertilizers industry, Dr Ghosh emphasized that the Government must not overlook the importance of the manufacture of bye-products of the ammonium sulphate industry and expressed doubts whether the proposed erection of a single fertilizer plant can fulfil the requirement of bye-products. In his opinion, the establishment of at least four units for the production of fertilizers is necessary. Dr Ghosh pointed out that during the discussion of the report of the Fertilizers Technical Mission no attention was paid to the possibility of a healthy combination between the fertilizer industry and the coal tar distillation. Such co-ordination among basic industries is, according to him, best calculated to promote the growth of basic industries. Dr Ghosh advocated that genuine research work is today the main foundation of a chemical industry and it will have to be so in our case if we are to develop a sound and powerful chemical industry. Most of the chemical and pharmaceutical industries in the present state can hardly afford to undertake research in their laboratories, and as such the encouragement of co-operative research on a wide scale appears to be the only solution of this difficulty. He expressed satisfaction at the attempts on the part of the Indian Chemical Manufacturers Association to start a co-operative organization for industrial research. Dr Ghosh bitterly criticized the Government's anti-national attitude of facilitating imports of drugs and chemicals which can be obtained from foreign countries at a cheaper price.

SCHEME OF INDIAN RESEARCH FELLOWSHIPS

At a conference of Chemical & Pharmaceutical Manufacturers and representatives of universities and research institutions, held recently under the auspices of the Indian Chemical Manufacturers Association, the following resolution was passed:

> "This Conference of Chemical and Pharmaceutical Manufacturers and of representatives of Universities and Research Institutions in India considers that closer co-operation and co-ordination between the different Departments of the Government of India, Research Institutions and the Industry, are necessary for the commercial utilization of the research work carried out in the Universities and Research Institutions, and further development of Chemical and Pharmaceutical Industry. With that object in view the Conference recommends the establishment of Industrial Research Departments in every University and Research Institution with adequate financial aid from the State and the industrialists to be worked under the guidance and control of Research Councils comprising of the representatives of the Industry and Scientific experts. This Conference further urges the Indian Chemical Manufacturers Association to formulate a scheme of industrial research fellowships to be started for promoting industrial researcl. in Universities and Research Institutions in the country."

ANNOUNCEMENT

The University of London has conferred the Degree of Doctor of Science (D.Sc.) on Dr C. N. Acharya, Chief Biochemist to the Imperial Council of Agricultural Research, for his investigations in the field of biological decomposition of organic materials, with special reference to the preparation of farm and town composts.

ERRATUM

Please *read* 'pared which records the population in the three age' *for* 'part in this period. Thus the table 11 has been pre-' on page 234, line 21 from top (column 1), in our December issue.

SCIENCE IN INDUSTRY

'LIGHTHOUSE' TUBE

The General Electric Company's Electronic Laboratory has recently developed a new disc-seal electronic tube, known as the 'Lighthouse' tube. This tube is a megatron tube and is expected to make possible the radio relaying of FM radio and television programmes in future. According to a brief description of this tube, contained in a report of the *Science News Letter*, August 19, 1944, the new disc-seal electronic tube eliminates the conventional type of grid, anode and cathode. Instead of components being fitted around one another as in the past, they are now constructed in parallel planes or layers, with glass and metal fused in rigid, inseparable units, capable of withstanding severe handling. A new family of ultra-high frequency electronic tubes,

circuits, and apparatus, specific information of which is not available for reasons of necessary military secrecy, operate in parts of the radio spectrum. Extremely compact in structure, the tube represents an important advancement in frequencies and power available for use in the electronics field. 9459

The failure to produce electronic tubes and apparatus of sufficiently high power hitherto acted as the main obstacle in the way of using higher frequencies. The use of higher frequencies necessitates the use of smaller tubes with consequent reduction in power. The parallel plane construction of the megatron tube, it is stated, makes possible production of high frequencies at sufficient power. Besides, many high and ultra-high frequencies are also available, from which any one may be selected for a particular service, such as television, FM, radar etc., and used without interference by others.

MECHANIZING AUSTRALIAN VEGETABLE PRODUCTION

THE Bulletin No. 52 of the Australian Association of Scientific Workers contains results of a recent drive for vegetable production through mechanized farming in Australia. Nearly two years ago the Commonwealth Government introduced mechanized methods for the production of vegetables and secured the services of some American specialists in this field to take advantage of the scientific experience gained in mechanization in the U. S. A. The total vegetable acreage in Australia annually averaged about 250,000 acres during the pre-war period from 1935-1939. In 1943-44, as large an area as 468,000 acres, nearly double the pre-war figure, accounted for Australia's vegetable production. The principal vegetables whose production has been thus increased include potatoes, carrots, onions, tomatoes, peas and navy beans.

Tractors—row crop tractors, which are now imported from America under Lend Lease, form the basis of the mechanization scheme. The Australian technicians have redesigned all the attachments and accessories for row crop culture on the basis of pilot models brought in from the U. S. A., which are now being manufactured in Australia. This equipment has made possible quick change over from hand-hoe culture to multi-row vegetable culture. A grower equipped with one of the small 3 H.P. garden tractor can handle as many vegetables as 7-10 men could do with hand tools. Seeding, cultivation and crop dusting can now be done at the rate of 20-30 acres per day per man. The great increase in speed is better reflected in the production of green peas for canning and quick freezing. The old methods of hand harvesting required about 130 man hours per acre to pick the crop. The mechanical methods which have completely eliminated hand picking have reduced the harvesting labour requirement to only 10-15 man hours per acre.

BIOCHEMICAL FOSSILS

PROF. D. L. FOX of the Scripps Institution of Oceanography in *Science*, August 11, 1944, reports the quantitative and qualitative carotenoid pigments encountered in marine sediments of hundreds or thousands of years standing. These highly labile compounds are capable of being preserved over vast ages of time, due to the lack of free oxygen, absence of light and perpetual temperatures of nearly o°C in the buried strata of the Ocean floor.

Pigmentary compounds of the plant and animal prophyrin series have been encountered in petroleum, coal and shale oils. Similarly, other chlorophyll derivatives accompanied by carotenoids and sometimes associated with pigment common to petroleum occur in long and deeply buried marine sediments. These ancient deposits may be regarded as diagnostic features in the search for biochemical processes in the origin of petroleum and allied natural deposits.

Carotenoids have been reported in Moor soils, in muds from lakes, marshes, and underground caves.

In the present investigation attention is directed to the probable ages, history and biochemical significances of these pigmentary compounds in natural deposits.

PRODUCTION OF OIL FROM PLANT MATERIAL

THE plant conversion process puts liquid fuel at the disposition of all civilized nations. Any country which is not blessed with natural oil and which has or can develop an adequate agricultural or forest production can now produce an important part of its liquid fuel needs. Time is not far off when oil products should be obtained from sources other than natural oil, as the experts in the field are inclined to think. Prof. E. Berl of Carnegie Institute of Technology in *Science*, April 21, 1944, states that by a controlled internal combustion one can get from corn stalks, corn cobs, sugarcane, bagasse, sea weed, algae, saw dust, Irish moss, molasses, sorghum, grass or any other carbohydrate containing material a substance called "Protoproduct" which is semi-liquid at room temperature and liquid at higher temperature and contains about 60 per cent. of the carbon content of the original plant material. The "Protoproduct" is a hydrophobic substance and separates easily from the watery medium, and no further concentration is necessary. It can be used as fuel oil or in Diesel engines.

About 50 per cent of oxygen is contained in plant material, *e.g.* in dry sugarcane. Protoproduct made from sugar cane contains 20-10 per cent of bound oxygen which can be removed by hydrogenetion as a result of which about 45 per cent of

the original carbon content of sugarcane, results as gasoline, kerosene, and lubrication oil—17·1 per cent of the original carbon content in sugarcane are found in this gasoline. Kerosene fraction contains 19·7 per cent. of the sugarcane carbon content. The remaining asphalt like material contain 15 per cent of the sugarcane carbon content and is derived mostly from the liquid content of the plant and can be used for purposes where natural asphalts are used. From 100 long tons dry sugarcane result 2·980 gal. gasoline, 3,430 gal. middle oil, and 1,210 gal. lubrication oil.

It would be wise and practical to use more and more agricultural products for the production of liquid and semi-liquid fuels.

SOME ASPECTS OF FRUIT CANNING INDUSTRY

SURESH M. SETTINA

DEPARTMENT OF CHEMISTRY, ELPHINSTONE COLLEGE, BOMBAY

(*Continued from last issue*)

Transport

The problem of transport is also of vital importance. Fruits may have to be transported over long distances either by road or rail. This has not only to be quick as fruit is a perishable commodity but it has to be efficient for if the fruits are transported and handled in a negligent manner spoilage may result. Inefficient packing, rough handling and dumping of different fruits together in closed wagons may spoil delicate fruits. The rates of transport are also going to affect considerably the price of the canned products. This applies both to the raw materials and the canned products. Government can help here in the initial stages of the industry by reducing the freight on canned products or fruits meant for canning. It can also improve upon the present transport facilities.

Marketing of Canned Fruits

The slow development of the fruit canning industry in this country is to some extent due to want of markets for the canned fruits. Low standard of living, prejudice against canned foods and a feeling that the Indian canned foods are inferior to foreign products have restricted the sale of Indian canned products and the Indian producers had to turn to foreign markets for the disposal of their products. The present war has given a fillip to this industry but this has been offset by the difficulty of getting the containers. The import figures for canned and bottled fruits for the two years just preceding the present war, given below, will show that the imports of such products in India were not inconsiderable.

In post war India it is difficult to visualise what exactly will be the difficulties of the fruit canning industry. Anyway if a large market has to be opened up in India it is imperative that the prices of canned fruits are lowered by efficient organisation and production and the quality of the products brought on a par with the foreign products. As shown later, Government can help substantially in this matter. The Malayan Pineapple Industry succeeded because it marketed cheap products of good quality so that they could find a place in the budget estimates of a middle class family.

Imports of Canned or Bottled Fruits[9]

From	Quantity in cwts.		Value in Rupees	
	1937-38	1938-39	1937-38	1938-39
United Kingdom ...	2,994	2,261	1,64,898	1,40,108
Strait Settlements ...	20,075	21,991	1,98,296	2,05,350
Hongkong	217	116	5,394	2,891
Commonwealth of Australia	3,821	3,792	1,11,772	1,11,956
Other British possessions ...	314	562	5,838	9,033
France	143	65	15,290	5,003
Italy	668	629	24,423	25,181
Japan	239	421	5,368	7,356
U. S. A.				
via Atlantic Coast ...	1,761	680	64,083	23,713
via Pacific	16,260	13,192	6,09,576	4,68,688
Other foreign countries	133	172	6,660	10,034
Total	46,625	43,881	12,11,598	10,09,313

The exports of Indian canned fruits or fruit products prior to the war were not much and mango pulp and slices formed the bulk of the exports. If the exports are to be increased markets must be developed but it is not easy to oust countries with well established canning industry from the foreign and home markets and establish the sale of our products. A start must therefore be made with our exclusive fruits like mangoes canned both as pulp and slices. When these fruits establish their reputation in the foreign markets it will not be very difficult to introduce other common fruits on the

reputation of our exclusive fruits. High rates of tariff, food acts, standardisation specifications and last but not the least the prejudice against Indian goods are hurdles over which we shall have to jump successfully if our canned fruits are to sell in the world markets.

In the marketing of canned fruits it should be borne in mind that the fruits which have the widest appeal are those which are not easily obtainable in the fresh state or obtainable only at prices beyond the reach of the consumer with a small purse. If the product marketed is to be cheap it is necessary to reduce the number of middle men as far as possible. The fruit marketing board can very well undertake the marketing of canned fruits.

Need for Research

There is constant need for scientific research in the canning industry. Numerous are the problems which crop up. New fruits to be canned require elaborate investigations if these canned fruits are to satisfy the markets. The canning of the usual fruits for which data is available also raise problems which have to be tackled. The variety growing at some place may not be quite amenable to canning conditions. The effect of storage under tropical conditions, the density of syrups for our fruits, the suitability of various colouring matters, the problem of spoilage, the possible means of holding over supplies of fruits for canning at a later date require study under the conditions prevalent in the various parts of this country. While every cannery which claims to be modern will have a small research laboratory to solve its individual problems there will still remain a need for one or more research stations to investigate broader and more fundamental problems of canning *e.g.*, experiments on the corrosion of plates, substitution of newer types of containers etc. It should also be a centre for the dissemination of information on canning by means of bulletins and should attend to the inquiries of canners and advise them where such an advice is likely to result in an improvement of the product. It might also give a course of instruction in canning practice. No doubt at present some notable work is being carried out at a few experimental stations in India like Poona and Lyallpur but a big central station like the Fruit and Vegetable Preservation Station at Campden in England is a necessity. The station has from the beginning taken a broad view of all canning problems and has become famous the world over for its investigations into the fundamental problems and for its help to the canning factories in the United Kingdom. Now administered by the Department of Scientific and Industrial Research it is maintained partly by a grant from the Government and partly by contributions from the canning and allied trades which are represented on the Technical Advisory Committee and on the Managing Committee. Apart from the pursuit of research and expert advice on technical problems, it also conducts courses of instructions in the principles of canning where students from different countries take training. The station also tests samples for the National Mark Scheme.

Advantages and disadvantages of Fruit Canning Industry on a Large Scale and Cottage Scale

There are conflicting views on the subject whether canning industry can be worked on the cottage scale or not. Due to lack of transport facilities and the excess of production over consumption, surplus fruit is left at times on the site of produce and needs some outlet. This can be canned if a small cannery with home canning appliances is set up at such places and this will result not only in the canning of surplus fruit but there will also be no trouble of transport of fruits over long distances to a big cannery especially during rainy season when it is difficult to do so. The canned products can be transported when conditions permit. The bulk to be transported is also thus reduced. Small scale canning will lead to the elimination of charges incurred over collection of big capital, registration, factory over head, costly foreign machinery etc. The small scale manufacturers canning different products at different centres of fruit production should be brought together under one or more co-operative concerns for marketing the product. This body should buy the cans, bottles and other requirements and distribute to the manufacturers. It should then label the products under its own name and do the work of advertising and marketing. It may also maintain technical advisers, canvassers, research workers etc.

A large scale canning factory will be in a position to run profitably if it works at its maximum with resulting mass production and markets will have to be found for these products. Again such a factory must can different fruits or else close down for some months owing to the strictly seasonal supply of fruits.

Against the advantages of canning as a cottage industry may be listed its disadvantages. The products of different small scale canners will not be of uniform quality. Proper sorting and grading will be difficult for people whose main aim will be to dispose off their surplus fruit. Syruping, filling, sealing and processing may not be properly carried out and may lead to spoilage as has been observed in some countries, sometimes even to food poisoning. Proper hygienic conditions may not be maintained. If proper control can be exercised through food inspectors over small scale manufacturers, small scale co-opera-

tive concerns do deserve encouragement, especially in this country where any small addition to the income of the rural population is always welcome.

It has been estimated by the National Planning Committee's Sub-Committee on Horticulture that a fair sized canning factory requires a capital of Rs. 10 to Rs. 15 lakhs but at a conservative estimate Rs. 5 lakhs would suffice for a medium sized factory. The Committee was also of the opinion that "in so far as the household or local demands are concerned, small industrial units may be started with a capital of eight to ten thousand rupees on co-operative basis, but where production is large and is meant for preservation, either for interprovincial or international trade, it should be in the hands of big industrialists."

How the Government can help the Industry

Various measures have been suggested from time to time as to how Government can help the fruit canning industry. They may be briefly summed up. The Government can help the raising of capital for large canning ventures by an assured capital from Government or by a subsidy from the Government per can produced for the first few years and later only on cans which are exported. Import duties may be imposed on the foreign canned products which are likely to compete with our own. The duty on the materials used for canning like cans, sugar, canning equipment, etc. may be reduced or removed altogether for a few years. A reduction in freight and proper transport facilities for the transport of raw fruits for canning will go a long way to help the industry. The trade commissioners in foreign countries may be instructed by the Government to make propaganda for our products and get prominence for them in International exhibitions. The Government can put the services of the Agriculture Department at the disposal of the canning industry so that the canners may get expert advice on the availability of fruits and their keeping qualities and the cultivators on the improvement in the varieties of fruits with a view to get better results in canning and so on. Through its department of Industries the Government can give expert advice on technical matters. All this may be done efficiently by one or more research stations as mentioned before. The Government by enforcing a National Mark Scheme or some other measure which permits it to examine the products canned and prevent the export or local consumption of products found below mark will create a good reputation for Indian products locally and in foreign countries. Such a control is absolutely necessary because if in the initial stages of our industry spurious goods are exported or even allowed to be consumed locally and if this results in any deleterious effects on the health of the consumers it will deal a staggering blow to the reputation of our products.

Fruit Canning Industry in the other Parts of the World

The fruit canning industry has developed to a very great extent in the U. S. A., Hawaii, Malaya, Australia, Japan and Canada as will be seen from the following export figures.

Summary of exports of canned fruits from principal sources (quantity in thousand cwt.)[7]

Country	Year 1936	Year 1937	Percentage for 1936
U. S. A. ...	2,306	2,397	48·5
Malaya ...	1,199	1,259	25·2
Australia ...	443	579	9·3
Japan ...	434	492	9·1
Canada ...	165	240	3·4
Spain ...	114	...	2·4
S. Africa ...	64	35	1·3
Belgium ...	12	8	0·3
France ...	7	8	0·2
United Kingdom	12	14	0·3
Total for 10 countries ...	4,756	5,032	100·0
Shipments of canned pineapples not included above.			
Hawaii to U. S. A.	4,893	5,057	
Philippine Islands to U.S.A.	64	68	
Formosa to Japar	330	...	

The grand total of the export of canned fruit in 1936 amounted to over 10 million cwt. of which more than ⅔ consisted of canned pineapple.

While the U. S. A. is the largest producer and exporter of canned fruits it loses this place in the case of other canned products. Prior to the present war, Italy stood first in the export of canned vegetables, Japan in the export of canned fish, Netherlands in the export of canned milk and Argentine in the export of canned meat.

The largest single importing market for most canned foodstuffs is found in the United Kingdom, the total being 41·6 per cent of the world exports of canned foodstuffs in 1937, fruit imports being as high as 72·8 per cent of the total world exports.

To just give an idea of the extent to which mechanical efficiency has been achieved in some of the foreign factories the figures published by one of the biggest pineapple canning factory in Hawaii a few years back may be given. The speed of the processing machines was 150 cans per minute and that of labelling 1400 cans a minute. On a record day this cannary packed 3,497,388 cans, giving an average of 2,776 cans packed per minute. Tin plates fed in

a machine give finished cans at the rate of over 300 cans a minute.

Other countries, like Egypt, Palestine, Eire, Kenya, Mauritius and Jamaica are not allowing the grass to grow under their feet and are actively trying to build up fruit canning industries.

Fruits Preservation Industries other than Canning or Bottling

It is not the purpose of this article to discuss the various methods of fruit preservation, however, a brief mention may be made here of the other fruit preservation industries. These are, salting of mangoes, drying of bananas, roasting of cashew nut, preparation of fig, guava, papaya, gooseberry and other jellies and marmalades, preparation of chutneys and pickles, candying of 'bor' and the two large industries *viz.*, sun drying of fruits and dehydration of fruits by artificial means.

Sun drying of fruits like dates, figs, jack fruits etc. is one of the oldest and most important food industries and there is scope for extensive development of this industry in this country as they are consumed for their distinctive taste which is in many cases different from that of the fresh fruits. Asia Minor, Greece, Spain and other Mediterranean countries and of late California produce most of the world's supply of sun dried fruits.

The imports in India of dried, salted or preserved fruits and vegetables, not canned or bottled, were valued at Rs. 1,09,51,059 in the year 1937-38 and at Rs. 87,66,206 in 1938-39.[9] Though these figures are for fruits and vegetables together the imports consisted in a large part of fruits like almonds, currants, raisins, dates and cashew nuts, coming mostly from Italy, Spain, Iran, Iraq, Bahrein Islands, Muskat territory, Greece and U. S. A. Apart from this a considerable quantity of preserved fruits are imported into India through the land routes like the Khyber Pass. The exports from India of dried salted or preserved fruits and vegetables, not canned or bottled, were valued at Rs. 19,47,867 in 1937-38 and at Rs. 32,00,866 in 1938-39.[9] It will thus be seen that there is plenty of scope for fruit preservation industries in India other than canning.

The dehydration of fruits and vegetables is an industry of recent times and was stimulated by the Boer War and the World War I. Enormous quantities of fruits and vegetables are dehydrated and shipped to the armies all over the world. The dehydration may be carried out by air, superheated steam, in vacuo, in inert gases or by the direct application of heat. Air, however, is the usual medium employed industrially. Dehydration industry is growing rapidly because of certain advantages it holds over sun dried products. Dehydrated fruits when cooked more nearly resemble the cooked fresh fruits in flavour and colour than cooked sun dried fruits. They are produced under better sanitary conditions than sun dried products which are liable to be contaminated with flying dust and subjected to insect nuisance. Sun drying again cannot be carried out in the rainy season. These and other advantages have led to the establishment of dehydration industry on a large scale in many countries.

Preservation of fruits at low temperature is also employed where facilities permit and where the duration for which they are to be preserved is short.

If juices of citrus fruits like 'santra' and 'mosambi' and other fruits like 'jamboo' and pomegranate are bottled and made available cheaply will be popular and their increased consumption will be beneficial from the nutritional point of view. There is no reason why they should not replace aerated drinks.

India is an agricultural country. Malnutrition is widespread in this country. There should therefore be a strong impetus for the widespread development of fruit cultivation and fruit preservation industries so as to bring within the reach of the masses at least some fruits. May be, without adequate State support we may not be able to compete in world markets in canned fruits in which other countries also deal like say pineapple, but a fruit like mango is our own fruit and it should capture the foreign markets even as the Malayan canned pineapple captured many foreign markets.

It will indeed be a tragedy if foreign concerns take this trade out of our hands. Of late, numerous foreign manufacturers in various trades have established their factories in India. It may not be long before foreign canners come and establish canneries for canning of fruits in this country and with their home market in their hand, with enormous capital behind them, technical experience and reputation one single factory may be sufficient to oust small Indian concerns even from our home market. Before that day dawns let us hope we shall wake up to the realisation of the need for the establishment of fruit canning industry on a sound basis in this country.

References

1 Hirst and Adam, Monograph No. 1 University of Bristol, Research Station, Campden, 1937.
2 Ball, *Food. Res.*, *3*, 13, 1938; B., 724, 1938.
3 Cameron, *ibid.*, *91*, B, 724, 1938.
4 Savage, *Lancet*, 4th Nov., 1938 and *Food*, Jan., 1940, 83.
5 Godden and Thomson, *J. Soc., Chem. Ind.*, *58*, 81, 1939; B, 545, 1939.
6 Fruit and Vegetable Production for Commercial Canning, *Bulletin No. 45*, Ministry of Agriculture and Fisheries, London, 1932.
7 A Survey of the Trade in Canned Food. *Report of the Imperial Economic Committee*, 32nd Report, London, 1939.
8 *Report of the Royal Commission on Price Spreads*, Ottawa, 1937, p. 70.
9 Sea-borne Trade of British India, 1940.

MEDICINE AND PUBLIC HEALTH

PENICILLIN FOR CIVILIAN USE IN INDIA

It is probably now a common knowledge that the American authorities have recently agreed to release limited quantities of penicillin for use of the civil population in India, and as a corollary they have stipulated that all use of it must be under strict Government control.

In order to ensure that the available supplies are equitably distributed throughout this country and reach patients to whom its administration is justified in the current medical practice, the distribution and use of penicillin is controlled by the Government of India through committee consisting of five members with the Director General, Indian Medical Service, as its chairman. This committee is known as the Central Penicillin Control Board, and it is imperative now on every importer of penicillin to comply with any control rules and regulations that may be issued by the Board from time to time. Publication No. 1 of the Board has already been published. This, besides giving the dosage and mode of administration of penicillin, includes also the diseases in which penicillin is indicated and contra-indicated. Copies of this pamphlet have already been supplied to the heads of the Government Medical Departments in Provinces and States.

Naturally the unusual healing properties of Penicillin have caught the imagination of the medical profession, so much so that often supply of this drug is requested for the treatment of indefinite cases where everything else has been tried and found to have had no results. One of the objects of the measures of control is to prevent this use of such a valuable drug. Its use is also prohibited in venereal diseases. It is as necessary with penicillin as with sulphonamide to know the nature of the infection to be treated. While some bacteria are extraordinarily susceptible to it, others are completely unaffected, and to use penicillin in an effort to eliminate them is a complete waste of valuable material. There are three groups of bacteria against which both the sulphonamides and penicillin are effective, with some important individual differences, and these account for most of the infections in which penicillin has been used.

Penicillin, in the first instance, will be supplied only to approved institutions, authorized to use this drug by or under the authority of the Board. Any stocks remaining over each month after the various Provinces have been allotted as much as they require will be sold by importers direct to medical practitioners and non-Government institutions under the following control.

Every request for supply of penicillin in such cases must emanate from a medical practitioner and should be accompanied by a certificate that the case for which penicillin is required is suitable for treatment which should be signed by an Administrative Medical Officer, *i.e.* a Surgeon General, Inspector General of Civil Hospitals, Residency or Agency Surgeon, or any of the "assessors" nominated by him for the purpose. These assessors will ordinarily be surgeons or specialists who have access to a suitable bacteriological laboratory.

In order to judge whether the use of penicillin is justified the assessors will require particulars of the case which must include the diagnosis of the case, basteriological findings, the doses, the mode in which penicillin is proposed to be administered and also the quantity required. If the assessors are satisfied they will sign a cetrificate that the case is suitable for penicillin treatment stating how much penicillin is to be issued. The importer on receipt of such a certificate will issue the amount of penicillin prescribed thereon. It is incumbent on every medical practitioner or institution obtaining penicillin to submit a case report through the Government Assessor on the prescribed Penicillin Chart, copies of which have been distributed to Provincial and State medical authorities.

A considerable portion of the quota allotted to India has already reached the hands of the importers. Stocks of penicillin at present are available with Messrs. Kemp & Co., at Bombay, Madras, Calcutta and Delhi, Messrs. Parke Davis & Co. at Bombay, Madras and Karachi, Messrs. T. M. Thakore & Co., Bombay, Messrs. Martin & Harris Ltd., Calcutta, Messrs. Volkart Brothers, Bombay, Messrs. D. M. Wadia & Co., Bombay and Messrs. Smith Stanistreet & Co., Calcutta.

INSULIN TREATMENT SIMPLIFIED

A synthetic product which is claimed to simplify the course of insulin injections for diabetes has been recently patented in America, according to a report of the *Liverpool Daily Post*. The patent arose out of the researches of Dr Johannes Buck, formerly a research chemist in Liverpool and now an American citizen. The synthetic product has the property of

slowing down the blood's ability to absorb insulin. Accordingly, it is claimed that it would be possible to give a diabetic patient a 24-hour supply of insulin in one injection. Ordinarily, an injection of this calibre would result in severe and possibly fatal shock to the patient, but the patented method has the effect of releasing insulin gradually so as to maintain the right amount in the blood.

THE MINIMUM REQUIREMENTS OF A HOUSE IN RURAL AREAS

"RUSTIC"

HOUSING conditions in rural areas differ widely from province to province in a vast country like India. In some provinces the villages are compact and separated from one another by long distances. But village streets are not well laid out and houses are built any how. In some other provinces the villages are compact and the streets are well laid out around a temple or other place of worship or tank. But the houses are built as attached blocks and each house is like a long corridor with cross walls, and a backyard. In some provinces the village is a nebulous aggregation of hamlets without definite streets or roads, sprinkled among paddy fields, or interspersed with ponds. The house consists of an enclosed courtyard with cattle shed in a corner and a number of rooms on the side of the courtyard. There is one kitchen for several members of a joint family. The grain is stored in the courtyard. There is no latrine or well or bathroom. These are not considered essential to the house. Windows are mere peep holes opening on to the courtyard. Natural lighting is poor and there is no cross-ventilation.

In a previous article[1] the writer has mentioned the defects that can render a house insanitary. In this article, the minimum essential features of a healthy house suitable for a rural family are considered, and a design is put forward embodying these features. An estimate of cost is also given. This design may be altered to suit local tastes and materials available. If a person desires to build his house to larger dimensions, or provide more rooms, or better materials for walls etc., he is welcome. This design is meant for the poor family in rural areas.

The average family in India consists of 5½ members (census of 1941). In Bengal there were 5·4 persons to a house in 1941 and 5·1 persons to a house in 1901. Hence the minimum design for a house must be suitable for 6 persons (consisting of a man, his wife, perhaps 3 children over 10 and 1 under 10) or 5½ adults.

This family will require at least 2 living rooms. Three may be better, but we are dealing with minimum standards. One living room is not sufficient, because (*a*) the room must be 5½ × 50 or 275 sq. ft. to provide 50 sq. ft. per head. A room of 275 sq. ft. is rather large (16′ × 17′) and not easy to roof over, (*b*) if some member of the family is ill, it will be necessary to provide some isolation so that the patient may get some rest and the illness may not be communicated readily to the other members, (*c*) if a guest has to be accommodated, it must be possible at least to allot one room for the men and boys and one for the women and girls, for sleeping at night. This is ordinarily done in Indian families out of considerations of privacy, (*d*) the grown-up children of a family must sleep apart from the parents, as far as possible.

In the design (Fig. 1) two intercommunicating room 10′ × 12′ and 12′ × 14′ are provided. There are 2 verandas, one in front and one behind. In the hot weather a veranda is the nicest part of the house to sleep in or indulge in a chat. The front veranda can be used by the men folk and the back veranda by the women folk. The verandas will also prevent the rain from beating into the living rooms through the windows. The two rooms can be adequately cross ventilated. All doors must have ventilator openings above.

There is a separate kitchen adjoining the back verandah ; with a window and a smoke flue. This is essential. Cooking in the living room makes it smoky and dirty.

The house has an enclosed backyard or compound. There is a well or tube well with proper platform and drain leading to a soak pit. There is a little enclosed bath room or bathing platform near the well and a latrine of the borehole or any other suitable type recommended in a previous article.[2]

If cattle and live stock are to be accommodated in a rural house a separate shed 12′ × 8′ may be built in the backyard, and a manure pit may be provided as shown.

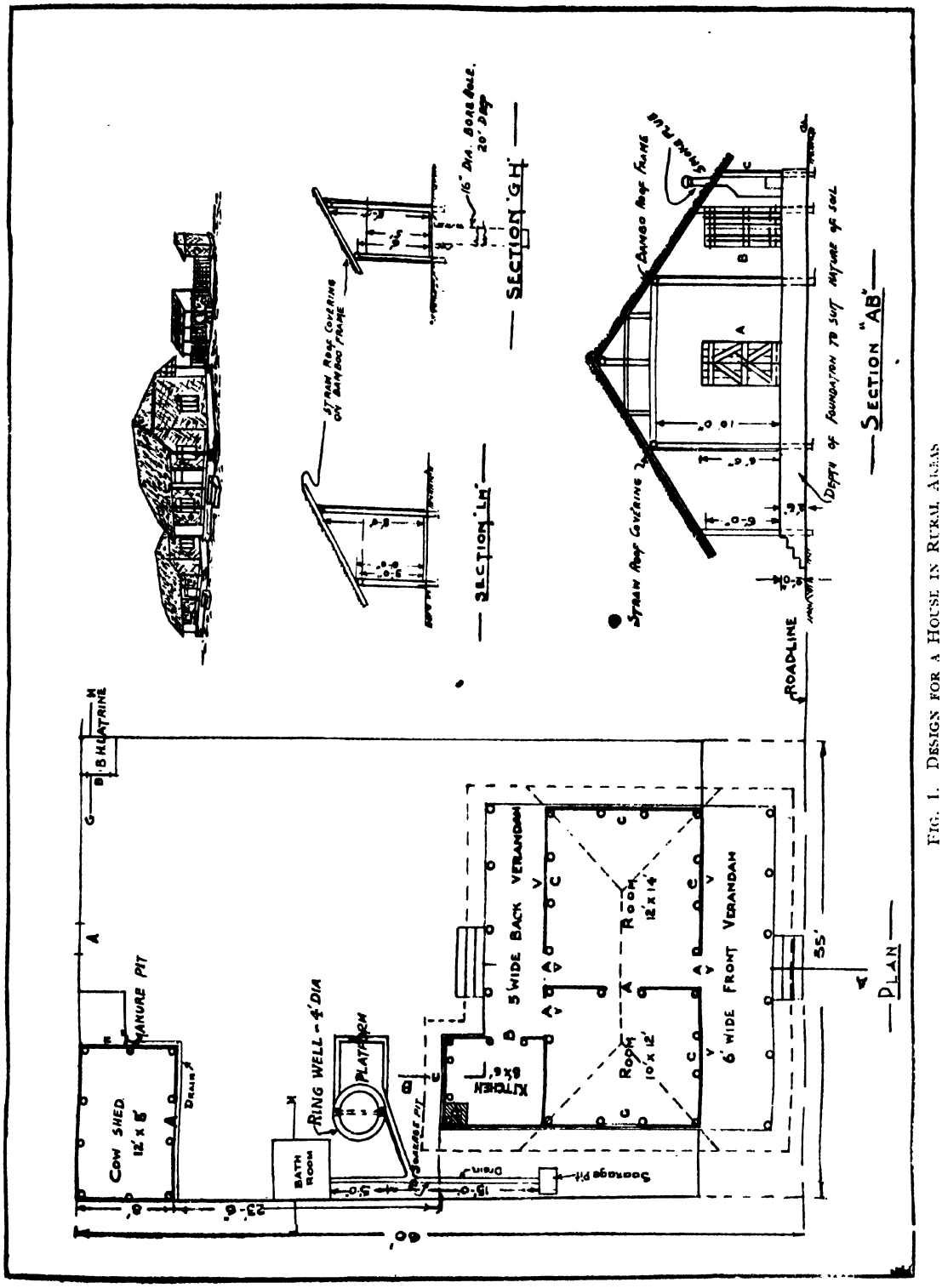


FIG. 1. DESIGN FOR A HOUSE IN RURAL AREAS

MINIMUM REQUIREMENTS: *Foundation*—To suit nature of soil. *Walls*—Bamboo or *Darma* mud plastered inside, white washed. *Roof*—Country wood or bamboo frame and covered with straw. *Floor*—Concrete, brick or earth floor finished with mud plaster. *Doors*—To have 4"×3" country wood frame with 1" thick shutters and with iron fittings, painted with tar. *Type-A*—Doors 3'×6'-6" brace and battened, double hung. *Type-B*—Doors 2'-6"×6' Brace and battened, double hung. *Type-C*—Windows 4'×3' Battened, double hung, iron fittings, 4'×6" country wood frame. *Type-V*—Ventilators 2'—0"×1'—3" Over doors and windows with gratings, no shutters. *Type-W*—Window 2'—6"×3'—0" battened, double hung, iron fittings, 4"×3" country wood frame. *Latrine*—Bore hole, 16" Dia. 20' deep with *darma* walls, bamboo frame, straw roof covering. *Bath*—4'-6"×4'-6" square, floor brick cement pointed or cement plastered over lime concrete.

The floor of the house must be raised at least 1′ above the ground ordinarily, and 2′ above ground in water-logged areas. It must be of concrete or brick plastered over with cement. A mud floor may be all right for a short time or in dry districts ; but an impervious floor with damp-proof course over the walls at plinth level is preferable in wet districts or where the sub-soil water is high.

The walls may be of any material that the villager can afford. The cheapest will be bamboo matting, preferably plastered with mud or cement and white washed in the interior. These walls are common in some places in East Bengal and look very trim. Such construction will do away with the need for digging for earth for house building and thereby reduce the number of breeding places of mosquitoes. Mud walls and brick walls may be built if desired but the interior must be finished with a white wash to reflect light. The smoke flue may be built out of mud and earthenware pipes. The roof may be of straw or tiles or terracing as desired. The head room in the living rooms may be 10′ – 0″. Such a house will have the following features :—

Floor space, including verandahs, rooms and kitchen 570 sq. ft. or 104 sq. ft. per capita.

Floor space in living rooms only 288 sq. ft. or 52 sq. ft. per capita.

Air space, including verandahs, rooms and kitchen 5852 c. ft. or 1062 c. ft. per capita.

Air space in living rooms only 5744 c. ft. or 680 c. ft. per capita.

The air space recommended per capita is—
500—540 c. ft. in European countries,
250—400 c. ft. in Great Britain and
20 cubic metres or 700 c. ft. by Fisher.[3]

The cost of this design depends upon the materials used. The initial cost can be kept low if temporary materials are used ; but the cost of maintenance will be low if permanent materials are used.

The land required is 35′ × 60′ for the house and the cowshed. This will be sufficient for building detached houses at the rate of 20 per acre. The cost of the site will be not more than Rs. 50 in rural areas.

The cost of this type of house is estimated as follows at pre-war rates :—

		Rs.	As.	P.
1.	Site 1/20 acre	50	0	0
2.	Cost of cottage and kitchen 600 sq ft.	600	0	0
3.	Ring well, pulley and platform, or 1/5 cost of tube well	40	0	0
4.	Bore hole latrine, soakage pit etc ...	20	0	0
5.	Fencing with live fence	20	0	0
		Rs. 730	0	0
6.	(Add) for cattle shed 12′ × 8′	70	0	0
	Total	Rs. 800	0	0

If such houses are built by the villagers themselves nearly Rs. 250 can be saved on account of labour costs. If the elders of the village would influence those who build houses to build them on a regular frontage, leaving a width of 25′ for the street, villages can look very pretty. The provision of one well or tube well for 1 to 5 houses will solve the water supply problem in many places. The provision of a latrine and manure pit will solve the problem of disposal of excreta and refuse in rural areas. The refuse and cowdung going into the manure pit will be composted naturally. This can be removed once a year and used in the fields.

References

1 Post War Housing and Town Planning in India—Rustic —SCIENCE AND CULTURE, *9*, 390, 1944.
2 Some Hints for the Disposal of Excreta in Rural and Small Urban Areas in Bengal—Rustic - SCIENCE AND CULTURE, *9*, 294, 1944.
3 *Quarterly Bulletin of the Health Organisation of the League of Nations*, *1*, 520, 1932.

BOOK REVIEWS

Radio Waves and the Ionosphere.—By T. W. Bennington. Published by Iliffe & Sons Ltd., London. Price 6 shillings net.

In modern times long distance radio communication plays an important rôle in our daily life. Nevertheless few people have more than a passing acquaintance with the ionosphere, the radio roof of the world, which is solely responsible for long distance radio wave propagation. The book under review is an excellent attempt to describe the essential features of the ionosphere in all its important aspects. It appears to be the pioneer of its kind in giving a simple and concise account of ionospheric phenomena in connection with short wave propagation. Such a popular and connected account embodying in its small compass all the relevant facts and figures about the ionosphere has not, as far as is known to us, been published before.

The text has been divided into six chapters. In the first chapter the distinction between ground waves

and sky waves and their performance in relation to wavelength has been discussed. In the next chapter the effect of solar radiation on the atmospheric gases in connection with the origin and stratification of the ionosphere has been explained. The third gives a lucid description of the methods utilised for the sounding of the ionosphere and describes the nature of the data obtained from these soundings. The variations in the ionisation of the various layers of the ionosphere with time are discussed in the next chapter. Due emphasis has also been given to long period variations such as those associated with the solar cycle. In the next chapter the author explains the method by which the data obtained from vertical incidence soundings of the ionosphere are utilised for deriving the transmission characteristics for long distance radio communication, namely, the maximum usable frequency and skip distance. The last chapter embodies a nice description of ionospheric disturbances and other abnormalities and their association with magnetic storms, sunspots and aurorae.

The author has presented the subject with commendable lucidity. The scope of the book is quite comprehensive so far as the requirement of the man-in-the-street is concerned. The author says in the preface that anyone who is capable of reading a simple technical article should be able to read and understand this book, and if he understands it, there is occasion for hope that his knowledge of short wave problems will be considerably improved. On reading the book one feels that the hope of the author is amply justified.

J. N. B.

Beginnings of Modern Education in Bengal : Women's Education —By Jogesh Chandra Bagal. Published by the Ranjan Publishing House. Price Rs. 2/8.

Women's education has to-day a recognized and indisputable place in the educational scheme of this country. The early efforts of the missionaries and other distinguished educationists and public spirited men towards the cause of female education in Bengal during the first half of the nineteenth century make interesting history. Mr Bagal who has made his mark as the author of several books has done well to trace the early history of this development which has so largely contributed to the culture and general uplift of modern Bengal. He has mainly confined himself to the period from the formation of the Female Juvenile Society in 1819 up to the establishment of the Bethune School in 1849 and its reorganization in 1856 and has recorded the activities of such pioneer societies as the Female Juvenile Society, the Ladies' Society, the Ladies' Association and the Serampore Mission. The facts have been laboriously collected from various scattered papers, journals, records and personal dairies of the time, most of which are now available with great difficulty. The incorporation of a number of important correspondence that passed between Raja Radhakanta Deb and Mr J. Drinkwater Bethune and Mr Bethune and Dalhousie in the appendix has further increased the usefulness of the book. For the students of education the book will be highly useful.

S. N. S.

A Text-book of Botany (for junior students)—By B. C. Kundu. Published by Das Gupta & Co., 54/3, College Street, Calcutta. Pp. 402. Price 6/8.

The book is the outcome of a fairly long experience of the author as a teacher of elementary botany and it embodies the essentials of a first course in botany, designed to meet the requirements of students of different Indian universities preparing for the Intermediate Examination in science and for other examination of a similar standard.

The pages bear the impress of an experienced teacher who realized the difficulties of junior students and attempted to solve them.

The subject has been divided into a number sections, *e.g.*, morphology, anatomy, physiology, ecology and systematic botany although the author believes that botany should be presented as one unit and hence morphology, anatomy and physiology should be studied together as far as practicable.

The subject matter has been treated in such a way that it may interest the young learners and with this end in view the text has been copiously illustrated, which have been either drawn from nature or from microscopic preparations made by the author himself ; and in physiology simple experiments have been suggested with inexpensive apparatus, so that every pupil in a class would be able to perform these.

Since the publication of a text book of botany by W. H. Gregg of Hughli College, Bengal (1880) and Manual of Botany by G. C. Bose of Bangabasi College, Calcutta (1920), botanical teaching in Bengal, or for the matter of that in India, has developed in rapid strides. The accumulated observations of the Indian flora extending over this long period have all been incorporated in the book under review that has considerably enhanced its value not only to the students but also to the teacher.

Although, the author has taken infinite care in illustrating the chapters on morphology, and the families of flowering plants from the Indian examples, the life history of cryptogams are not similarly illustrated. It is high time, that text books on Indian botany should be written on the life history of plants

based on the studies of local types and not borrowed from sources outside India.

The author has preferred to follow Benthan and Hooker's system of classification, in spite of the fact that Engler's system has been recommended by several Indian universities. In citing examples, it is desirable that an uniform system is adopted and with a little more care, could the nomenclature have been brought up-to-date.

It is hoped that like the author's previous work on "Text book of Biology" this book will also have a large circulation amongst the teachers and students of our Indian universities.

A. K. G.

A Source Book of Agricultural Chemistry.—By Dr Charles A. Browne, Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture. Published by the Chronica Botanica Company, Waltham, Mass, U. S. A., 1944. Pages 290. Price $5.

This is a highly important and well documented publication dealing with the development of chemical science with special reference to agricultural chemistry from the time of the earliest Greek philosophers to the beginning of the modern period, *i.e.*, up to 1887. The book has seven chapters, the first dealing with agricultural chemistry in ancient times, the second covers the Alchemical and Iatrochemical periods, the third deals with the period of Robert Boyle, Hooke, Mayow, Hales and others *i.e.*, the period covering the establishment of the Royal Society of London, the fourth deals with the phlogiston period and the fifth with the notable period in which Black, Priestley, Ingen-housz, Senebier, Cavendish and Scheele flourished; the sixth deals with the period of Lavoisier, Chaptal, de Saussure, Davy, de Candolle. In this period chemistry was founded on a quantitative basis due to the establishment of the law of conservation of mass by Lavoisier and the true understanding of the phenomenon of combustion (slow and rapid) and its relation to animal respiration. The last chapter deals with the beginning of the modern period in which the quantitative methods of Lavoisier were introduced in agricultural chemistry by his country man Boussingault and its development by Mulder and specially by the great German chemist and teacher Baron Liebig. The author has achieved remarkable success and has produced an excellent history of chemistry in which the life and the achievements of almost all the celebrated chemists have been recorded. He has quoted the original publications of these great men and hence this is a veritable source book containing an accurate record of the development of chemical science applied to agriculture. His estimate of the merits and achievements of Palissy, Bacon, Paracelsus, Van Helmont, Glauber, Boyle, Hooke, Mayow, Hales, Becher, Stahl Black, Priestley, Ingen-housz, Senebier, Cavendish, Scheele, Boussingault, Mulder, Liebig and others are very clear and impartial. The author has brought out the fact very conclusively that all the leading chemists of the past took a very keen interest in agricultural chemistry and advanced our knowledge on this subject.

Even the great chemist Liebig, whose writings deeply impressed agricultural science and practice in Europe did not realise the importance of supplying nitrogenous manure to the soils as is evident from the following lines taken from his publication in "Farmer's Magazine", 1874:—"If the soil be suitable, if it contains a sufficient amount of alkalies, phosphates and sulphates nothing will be wanting. The plants will derive their ammonia from the atmosphere as they do carbonic acid." A careful study of this important publication shows that success in agricultural chemistry and improvement in crop yield was effected when experimental and quantitative methods were adopted in crop production. In this respect the establishment of chairs of agricultural chemistry and agricultural botany in universities and technical high schools and the starting of experimental farms or stations have played a very big rôle. Food production is undoubtedly the biggest industry all over the world and it is high time that following the lead of U. S. A. and Europe professorships in agricultural chemistry and experimental stations and farms with qualified staff should be created all over this country.

The author and the publishers deserve our heartiest congratulations for this important and useful publication which should be widely read by chemists, botanists and agriculturists. The printing and the get up of the book are of a high order and the price is moderate.

N. R. D.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

SLOPES IN THE INDIAN ATMOSPHERE

ACCORDING to Kelvin and Rayleigh, a surface of discontinuity separating two fluids of comparable density is highly unstable except in the neighbourhood of the origin of the discontinuity. It is near this origin that the highest density gradient should be in evidence in horizontal sections of the atmosphere. The expression "comparable density" for the atmosphere does not appear to have been specifically defined.

On the average, the surface density[1] of the north subpolar region in the winter is about 25 per cent. higher than that of the equatorial region. The corresponding contrast in the southern hemisphere is no more than 5 per cent.

The reversal of the sign of the temperature gradient on the eve of the advent of the monsoon is no doubt due to the quasi-periodic advance across the equator of the monsoon current from the southern winter to the equatorial Indian Ocean in conjunction with the prolonged heating of the Indian sub-continent. The surface temperature gradient over the Indian region thus assumes a NW-SE orientation.

As to the conditions aloft, the diagram (Fig. 1) shows[2] that during the eight months, October to May, the temperatures over southern India are appreciably higher than those over northern India in every layer upto a height of about the 11 km. level.

In the monsoon, on the other hand, the atmosphere over southern India is found to be appre-

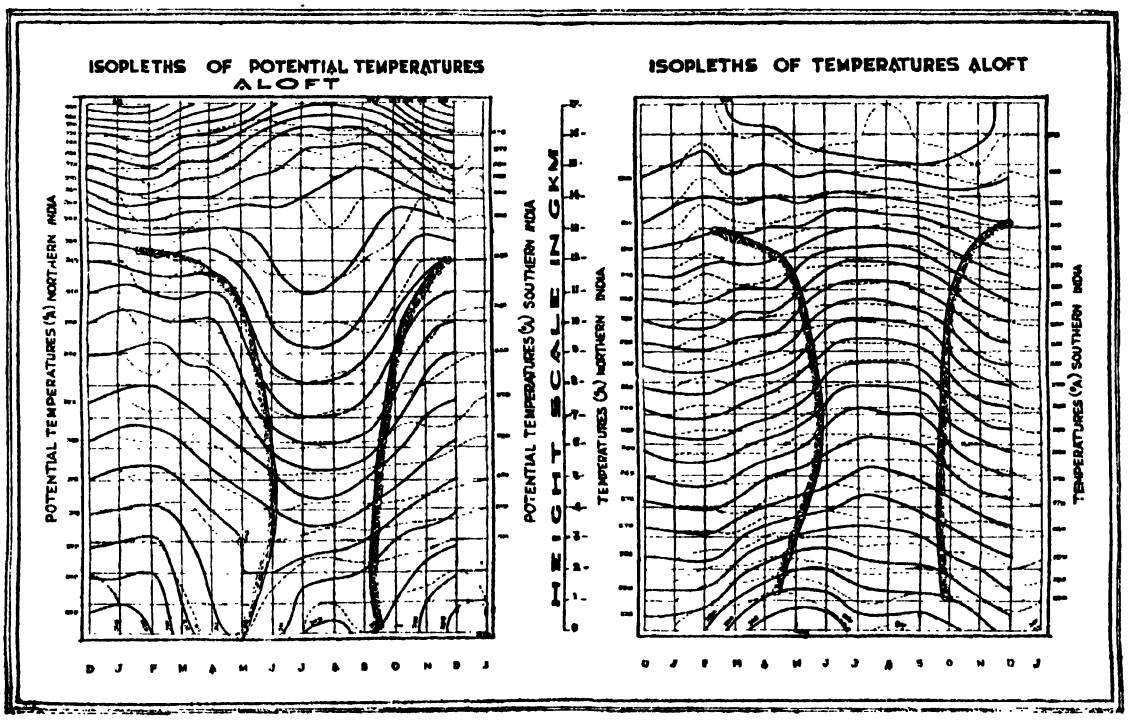


FIG. 1.

The horizontal temperature gradient in the Indian region[2] is approximately S-N in the winter. As summer approaches, this gradient gradually tilts to SE-NW. By May, however, a significant change takes place, *viz.*, the air over the Andaman Sea becomes somewhat cooler and therefore denser than that over Central India.

ciably ·ler than that over northern India, level for level.

The average horizontal gradient of temperature in every layer is of the order of 2-3°C per 1000 km, the sign of the gradient changing twice a year. The average temperature gradient at the surface during

the two transition periods is about 4-5°C in 1000 km. along the east coast of India.

A study of the average horizontal gradients of air density at the surface[4] in the Indian region is interesting. In the winter, for example, the contrast between the North West Frontier Province and Bengal, is of the order of about 20 gm/m³ per 1000 km, the density increasing towards the Frontier.

At the height of the monsoon, on the other hand, the corresponding average contrast is smaller, being of the order of about 10 gm/m³ per 1000 km, the density increasing towards Bengal. The distribution of density in the upper[1] layers do not show any strong gradients either. The significant fact is that, except during the winter, there are no locally strong gradients in the neighbourhood of those regions where cyclones usually form.

On individual occasions, a density gradient of as much as 50 gm/m³ per 1000 km at sea level may be found at the cold front of an extratropical cyclone. A density gradient of the order of 30 gm/m³ per 1000 km, which is frequently observed at the "cold front" of the extratropical cyclones, obtains also at the surface of the Indian Seas in the winter. In the monsoon and the transition months, however, the gradient over the Bay of Bengal is no more than 5 gm/m³ per 1000 km.

Of the annual output of cyclones[5] in the Bay of Bengal, only about 20 per cent. is to be credited to the winter and 55 per cent. to the monsoon. As to the highest recorded number of cyclones in a particular month, the following table sets out the relevant frequencies for the Indian Seas for facility of reference.

Table 1: Highest recorded number of cyclones for the Indian Seas in several months.

	Months											
	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Frequency											
Bay of Bengal	1	0	1	1	2	4	5	5	5	4	4	2
Arabian Sea	1	0	0	1	2	2	1	1	2	2	8	1

The table shows that the cyclones are more numerous and pronounced at the time of the reversal of the wind and temperature fields than in the winter.

The shaded strips in the diagram show the period in which average temperatures over northern and southern India are the same in horizontal layers. In the transition months, therefore, the entropy field of dry (tropical) and moist (equatorial) air tend to be uniform and the respective isentropic surfaces become horizontal.

It is significant that the shaded strips, by being almost vertical between the 2-11 km levels, mark out the pre-monsoon and post-monsoon transitions on land areas. In a horizontal layer in the equatorial over sea areas, on the other hand, the entropy field may be assumed to be fairly uniform in the equatorial belt on either side of the equator.

A temperature lapse, generally of 8°C/km and above, prevails in the lowest layer of dry air. The equatorial air is convectively unstable and this instability persists throughout the year. Again, Table 2 shows that "forced subsidence" (almost vertical isentropics) of dry air occurs practically throughout the non-monsoon period in the field A family echelon running over India and Burma. These are the warm anticyclones (with "heat lows" at the base) and migrate northwards or southwards with the sun.

The annual variation of the thickness of the nearly adiabatic layer is set out in the following table. The top of this layer is called the "free subsidence threshold" because dry air in this layer may occasionally subside freely to the ground. It may be added that "forced subsidence" occurs when forced downward flow is large compared with free upward flow (free convection), caused by gravity, in air of variable density owing to surface heating and other causes.

In the transition period, the atmosphere in the generative shell[6] in the Indian region has a highly rickety structure because both vertical and horizontal stratifications are destroyed. The slow dissolution of the transition fields under impulses, on the other hand, suggests that a dilatation axis in a horizontal plane must be acting as roller bearings between the dry and the moist wind systems.

The "outburst" or "onset" of the monsoon is thus an event which clearly marks that point of time when the entropy field over practically the whole of the Indian region, both land and sea, becomes uniform below the directive[6] shell. Similar conditions obtain at the time of the "retreat" of the monsoon. These fluctuations are large scale isentropic flow patterns, mostly in horizontal sections, governed by the pulsating monsoon current across the equator.

Let two distant air masses be set in motion under balanced forces, or approach each other in such a manner as to allow time for the necessary adjustments of the pressure field over the region in question. As each current develops its own transitional air masses on the way, they can contact each other

only through the transitionals of each. When the motions of the parent streams are steady, the contrast of density in the adjacent transitional air masses is necessarily small.

A large scale development of transitional air masses might be checked if two distant air masses could be made to move with an acceleration. The nor'wester charts of Bengal show that new motions may arise in a wind field to which the old pressure gradient fails to adjust itself.

The horizontal gradient of density at the surface (NE to SW) on a few occasions of nor'westers may even be of the order of 200 gm/m^3 per 1000 km, which is about three or four times the hypothetical density gradient (average) in the winter between Siberia and India.

The occasional development of the exceptionally high density gradients in the nor'wester fields is no doubt due to dynamical causes. The squall fields, however, are extremely unstable and do not last for more than a few hours. An acceleration of two distant air masses approaching each other, thus fails to produce the density contrasts of the type that might be necessary to increase circulation with time in a cyclogenesis field.

Table 2: Free subsidence threshold for dry air—average thickness of layers in km, with nearly dry adiabatic lapse rates from the surface upwards.

	Months											
	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Kilometres											
Agra	1·5	2·0	3·5	4·5	4·5	3·5	1·5	1·5	2·0	3·0	1·0	1·5
Poona-Hyderabad	2·5	3·0	4·0	4·0	4·5	3·0	1·0	2·0	2·0	2·0	2·0	2·0

Briefly speaking, a vortex street may be generalized into a row of "sources" by the side of a row "sinks". The consecutive negative and positive "discs" of a "complex street"[7] may be ruptured causing a distortion of the street. Moreover, translation may bring the smaller "source" and "sink" vortices closer together, forming doublets.

A doublet gives rise to a vortex ring or loop in a plane, say, at right angles to the axis of a westerly street, for instance. It then drifts away eastwards from the axis. The isochrones (earlier thunderstorms in West than in East Bengal and up the rivers than in the delta) of the pure nor'wester squalls support this view.

Either the positive or the negative vortex in a street may develop translatory motion of its own when certain conditions are satisfied. For example, a cyclone between two streets of small wave lengths, while moving out of its initial setting between two streets, might come in close proximity to its source anticyclonic vortex. Similarly, a moving anticyclonic vortex may encounter its sink cyclonic vortex. The vortex loops may, therefore, develop also in sea areas. As a matter of fact, *seclusion* of "source" and "sink" (trough formation) may occur through translation.

The "col-activity" may be in evidence well ahead of nor'westers in the isobaric charts of 1 mb interval and also in the distribution of upper winds. The dissolution of a doublet may mean a tornado.

In regard to the process of a gentle flow of extra-tropical towards the equatorial along an isentropic surface, a glance at the diagram would show that cold air from northwest India, flowing southwards along the isentropics, would lose, on the average, a height of 1 km in a distance of 1000 km. On individual occasions, however, the cold air may descend to lower levels over the South Bay, the home of the transition period and winter cyclones.

The descending cold air, however, fails to establish, even in the winter, "cold" and "warm" fronts at the sea level in the same sense as those of extratropical cyclones. The reason is undoubtedly the "forced subsidence" of cold air into "heat lows" in the equatorial belt. The cold air is thus transformed into the tropical. The process persists[8] practically throughout the whole of the non-monsoon period. A cold air supply, flowing at the surface and directed to the South Bay from Burma side, is likewise problematic. A katabatic flow of cold air seldom reaches South Bay.

The conclusion, therefore, is that the slope between dry and moist air masses in a small enough

block of the Indian atmosphere, away from the *origin* of the surface of separation (such as neutral points) is thus either almost vertical or almost horizontal. The dilatation axes of a deformation field in three dimensions lie in the former and hence it will be referred to as the vertical "flat plate".

Table 1, along with the charts of density and pressure distributions at the surface, brings out the outstanding fact that slightly over 80 per cent. of the cyclones in the Indian seas form in fields of feeble rather than in those of strong pressure and density gradients.

For the local intensification of circulation, therefore, both dynamical and physical causes have to be explored. An echelon of circumscribed areas, joined to each other by "bottle-necks", comes into existence when two opposite streets of comparable wave lengths lie side by side with a phase difference of 180°.

It is observed from charts that one of the circumscribed areas in the echelon shows signs of a local growth of circulation with the strengthening of the "undisturbed" streams of the streets. Briefly speaking, the strengthening of the undisturbed stream is important from the point of view of the growth of net vorticity (of one sign) in the circumscribed area. The important discharges of vorticity in a circumscribed area are as follows:

(*a*) round a "col-oval" (produced by the belting of the two core-cylinders inside the circumscribed area in a medium of U_0) which ultimately forms the core of a simple vortex.

(*b*) the vortex layer at the end of the vertical "flat plate".

(*c*) the vortex layer that may eventually grow at the periphery of the "col-oval" or at the Rankine joint between a forced and a simple vortex.

Incidentally, in a street astride the equator, rotation of the vortices in the same row remains unchanged, but the associated pressure field is reversed as the equator is passed.

It is evident from the preceding paragraphs that in the method of forecasting by fields and streets, advection has to be traced in the xy plane to detect regions of possible convection along the z axis.

The steps in this method of forecasting may often be summarised in such working rules as "dilatation axis in humidity wave". It may be recalled that the *outflow axis* is in *convergent* channels and the *inflow axis* is in *divergent channels* between two streets. This particular rule is being successfully applied to the prediction of unseasonable fog formations and to the location of the thunderstorm areas in the monsoon, even without the necessary statistical background.

Moreover, the longitudinal contractions and expansions of the cyclic fields may often be correlated with the isentropic slopes.

S. N. SEN
S. P. SIRCAR

Central Meteorological Office,
McLeod Road,
Karachi, 1-5-1944.

[1] Sen, S. N., *Q. J. R. Met. Soc.*, *50*, No. 209, 1924.
[2] Eliot, J., Climatological Atlas of India, 1906.
[3] Chatterjee, G., *Upper Air Data*, *12*, Part B, 1939.
[4] Ghosh, U. N., *Scientific Notes, I. Met. D.*, *3*, 19, 1931.
[5, 6] Sen, S. N., SCIENCE AND CULTURE, *2*, 593, 1937; *9*, 90, 1943.
[7] Sen, S. N. and Ganesan, V., SCIENCE AND CULTURE, *10*, 56, 1944.
[8] Sen, S. N., Climatological Atlas and Atmospheric Vortex Streets (Unpublished).

A NEW SPECIES OF DISCOMYCETES FROM BENGAL, *MITRULA AGHARKARII* SP. NOV.

Mitrula (Latin *mitrula*, a small turban) is a genus of the Discomycetes having tiny fructifications with fleshy, erect, stipitate, sub-globose, ovate or clavate, glabrous, fertile heads, usually sharply delimited from the stipe and often slightly free from below. The spores are short, cylindrical, narrowly elliptical or fusiform and hyaline. It is included in the section *Hyalosporæ* of the sub-family Geoglosseæ, family Helvelleæ by Saccardo[1]. Lloyd[2], following the older idea of basing the genera on the most obvious microscopic features placed the genus under the second division *Leotieæ* of the family Geoglossaceæ. Only two species of *Mitrula* have so far been reported from India.[3] The new species closely resembles the



FIG. 1.

Indian species *Mitrula rosea* ~ Lloyd but differs from it mainly in having salmon-organge[4] coloured head which changes to orient-pink on drying, while in *Mitrula rosea* both stem and head are of a fine rose colour. Besides, the spores are much longer in the new species than in *Mitrula rosea*.

Two little fructifications of this species were first collected by the writer from the Senchal range (8000 ft.), Darjeeling in October 1931. One of the specimens was sent to late Dr E. A. Burt of Missourie Botanical Gardens for specific determination. In October, 1941, several specimens of this species were again collected during an excursion conducted in the Sikkim Himalayas by Prof. S. P. Agharkar. It was growing in a wet situation on bare soil along slopes by the road side between Rimbick (7500 ft.) and Batasi (6884 ft.) *via* Palmajua (7250 ft.). The writer, therefore, takes the liberty of naming this species after Prof. Agharkar.

The detailed morphological description of the species is as follows:

Fructifications fleshy, erect, stipitate, about 6-12 mm. high. *Head* distinct from stipe, with prominent convolutions, sub-globose to somewhat compressed or flattened, glabrous, shiny, colour salmon-orange when fresh but becoming orient pink on drying several heads often remaining confluent, dimension about 3-5 × 3·5-7 mm. *Stipe* slender, slightly compressed, with a few longitudinal furrows, colour orient pink when fresh, not changing on drying, about 4-8·5 mm. high and 2-3·5 mm. broad. *Ascus* clongate-clavate, hyaline dimension about 84-96-108 μ X 5-6-8 μ. *Ascospore* elongate-fusiform to sub-fusiform, often slightly curved, continuous, hyaline, smooth-walled, dimension about 8-12-16 μ X 3-3·5-4 μ. *Paraphysis* linear, hyaline, septate, slightly exceeding the asci.

Type specimen has been preserved in the herbarium of the University College of Science, Calcutta.

SACHINDRA NATH BANERJEE

Department of Botany,
Calcutta University.
20-10-1944.

[1] Saccardo, P. A., *Sylloge Fungorum*, *8*, 32-39, 1890.
[2] Lloyd, C. G., The Geoglossaceae, 1916.
[3] Butler, E. J. and Bisby, G. R., The Fungi of India, The Imperial Council of Agricultural Research, Scientific Monograph No. 1, Pp. 12, 1931.
[4] Ridgway, R., Colour Standard and Colour Nomenclature, Washington, 1912.

AUXINS AS RESPIRATORY CATALYSTS OR CO-ENZYMES*

THE term auxin is used as a generic term for substances showing growth promotion in the avena test. Went (1928) for the first time isolated auxin from the plant, devised the avena test for the quantitative determination of auxins. The chemical isolation and structure determination of auxin was accomplished by Kögl *et al* in 1933. At first they found two closely related substances which they named auxin *a* and *b*. Later (1934) they isolated a third substance having auxin activity which they identified as indole acetic acid. Since that time other compounds mostly synthetic, were found to promote elongation. These active substances are found to produce other physiological effects, *e.g.*, they cause cell proliferation, nuclear division, cambial activity, root promotion, prevention of formation of abscission layer, development of carpels and ovules, bud promotion and protoplasmic streaming etc. Such active substances are compounds of phenyle, indole, naphthalene, anthracene and fluorine. There are, however, some quantitative differences in the responses with the most active compounds of different groups. Indole acetic acid is one of the most active substances for causing cell elongation of the avena coleoptile but as a root inducing substance, it is not as active as napthalene acetic acid or indole butyric acid. The latter is particularly low in activity for cell elongation of avena coleoptile. There is another group of physiologically active substances, studied chiefly by P. W. Zimmerman (1942) which modify the pattern of leaves and other organs, which, however, do not relate to the present communication.

Because auxin affects so many physiological processes besides cell elongation, it appeared to many investigators that the auxin must have a fundamental function in the life of the plant. This consideration led many investigators to look for an increase in respiration due to auxin. Thimann and Commoner[1] showed that coleoptiles previously soaked in malate produced marked increase in respiration upon addition of auxin. From this and from other evidences they concluded that the auxin must play the part of a catalyst or co-enzyme in the succinic-fumaric-malic-pyruvic acid respiration cycle (Szent Gyorgy cycle). According to Avery (1942) the increase in respiration reported by the investigators is very small and that better proof must be found before any generalisation on the effect of auxin on respiration can be made. The present communication contains results obtained by us on the influence of the nature of the substrate solution in which the cut end of a motile leaflet dips, on the respiration of *Desmodium gyrans*. It will be seen that when the substrate solution contains 0·05% of sodium malate to which 0·0005% of indole acetic acid is added, there is an increase of respiration by 50%.

It is well known that when the cut end of a motile leaflet of *Desmodium gyrans* is dipped in tap water, the leaflet is seen to exhibit pulsatory movements. Invesetigations carried out in the Institute during the last three years have shown (1) that energy of pulsation is due to the break down of carbohydrates formed in the leaflet by photosynthesis; (2) the pulsation could be maintained continuously in the dark for a

few days when the cut end of the leaflet is immersed in one per cent glucose solution. Recently we have been engaged in the study of the influence of different substrate solutions on the respiration and pulsations of the leaflet of *Desmodium gyrans*. The apparatus used is a modified form of respirometer, which enables the simultaneous recording of both the pulsation and respiration of the leaflet. Under favourable conditions both show periodicities of similar form. The problem at present under investigation is to find out at which stage in the dissimilation of glucose, is the energy supplied for the maintenance of pulsations. Besides glucose, we have used as substrate, solutions of glucose-1-phosphate, sodium salts of pyruvic, malic and citric acids. So far we have found that glucose solution is most suited for the continued maintenance of the pulsations. We next proceeded to find out whether any of the respiratory co-enzymes like nicotinic acid and thiamin when added to glucose influenced in any way the pulsatory and the respiratory activity of the motile leaflet. Thiamin is a co-enzyme for carboxylase enzyme responsible for the break down of pyruvic acid to acetaldehyde and CO_2, while the amide of nicotinic acid is a component of the two dehydrogenases coengyme I and coengyme II. In one per cent glucose a considerable increase of the respiration rate of the leaflet was observed, but no significant change in this rate was noted when different concentrations of nicotinic acid and of thiamin were added to the glucose solution. The last named results are of a preliminary nature only and require repetition before definite conclusions can be drawn. At this stage we came across a report of the investigations of Thimann and Commoner, on the increase of the resepiratory rate obtained in malate treated coleoptiles to which a dilute solution of an auxin was added. We decided to test the validity of the observations of the previous authors, using leaflet of *Desmodium gyrans* as test object. The results obtained are given in Table I. Section A, contains the results obtained with glucose solution on the rates of respiration, frequency and amplitude of pulsation of motile leaflet of *Desmodium gyrans*. In every case the normal rate of activity of the same leaflet when the cut end is dipped in tap water is taken as 100. In the sections B, C and D, similar data are given when the cut ends of leaflets are placed in (*i*) 0·05% of sodium malate, (*ii*) 0·0005% indole acetic acid and (*iii*) a mixture of (*i*) and (*ii*) respectively.

Discussion of results—In a solution containing 1% glucose there is a considerable increase in the respiration rate, some indication of increase in the frequency of pulsation, but no change in the amplitude of pulsation.

With 0·05% sodium malate there appears to be a diminution in the rate of respiration, as well as of amplitude of pulsation. With 0·0005% indole acetic acid there is some increase in the rate of respiration and diminution in the amplitude of pulsation. When treated with a solution containing both the malate and auxin a 50% increase in the rate of respiration is observed, with a slight reduction in the frequency rate.

The rate of chemical change taking place in a tissue at a constant temperature depends on the concentrations of the substrate and the enzymes acting on it and of its break down products. The measure of chemical changes involved in the present case is the respiration rate. If it is found that on increasing the concentrations of the substance or any of its break down products the respiration rate increases, the indication is that the concentration of the enzymes is more than sufficient to deal with the substrates avail-

TABLE I

Section	Treatment	Change in respiration Ratio bet. normal rate and after treatment.	Change in pulsation	
			Frequency Ratio bet. normal frequency and frequency after treatment.	Amplitude Ratio bet. normal amplitude and amplitude after treatment.
A	Glucose 1%	100 : 293·6 ±15·9	100 : 104·3 ±4·2	100 : 100
B	Sodium malate 0·05%	100 : 91·29 ±4·6	100 : 96·76 ±3·04	100 : 84·5 ±5·6
C	Indole acetic acid 0·0005%	100 : 113·86 ±9·65	100 : 95·81 ±2·1	100 : 85·8 ±8·03
D	Sodium malate 0·05% Indole acetic acid 0·0005%	100 : 152·19 ±10·03	100 : 92·05 ±1·6	100 : 99 ±8·8

able in the tissue. Similarly if an increase in respiraton rate occurs when the concentration of a co-enzyme is increased, that particular substrate is present in the tissue in more than sufficient quantity. From the results given in table I it appears (*i*) the enzymes with their co-enzymes responsible for the dissimilation of glucose in *Desmodium gyrans* leaflets are present in sufficient concentrations to deal with additional quantities of glucose. *Desmodium gyrans* appears to be auxo-autotropic so far as the respiratory enzymes are concerned. (*ii*) Indole acetic acid is a respratory co-enzyme or catalyst for some substrate present in the leaflet of *Desmodium gyrans*, which appears to be a malate. It is not certain that the auxin is a catalyst in the Szent Gyorgy respiratory cycle, in which there is only a transfer of hydrogen from the substrate to oxygen without evolution of CO_2. Probably the auxin acts as a catalyst in an alternative cycle, *e.g.*, like the one suggested by Krebs, in which evolution of CO_2 takes place.

Details of the apparatus used and of further results of the investigation will be published in the *Transactions* of the Bose Research Institute.

D. M. Bose
B. K. Dutt
A. Guha Thakurta

Bose Research Institute,
Calcutta, 15-11-1944.

* Summaries of all the papers cited in the above communication including the one of Thimann and Commoner, (*Jr. Gen. Physiol.*, *24*, 279, 1941) which was not available to us, are contained in the valuable reports contributed by Avery, Van Overbeek and Zimmerman to the Cold Spring Harbour Symposia (1942) "On the relation of harmones to development".

THE OXIDATION REDUCTION POTENTIAL AND CATAPHORETIC VELOCITY

For a system of a reversible reaction of the type

$$AH_2 \rightleftharpoons A^{=} + 2H^{+} + 2\varepsilon \quad \ldots\ldots (1)$$

for the oxidation-reduction potential to be the same in different solutions of $A^{=}$ at different *p*H values, the activity of the electrons a_ε, and k must be the same,

$$K = \frac{{}^{n}A\ {}^{n}H^{2} + {}^{n}\varepsilon^{2}}{{}^{n}AH_2} = k\, a_\varepsilon{}^{2}$$

K in (2) and therefore E_{redox} is constant, since k, the dissociation constant of AH_2 and a_ε are the same in different A solutions at different *p*H values.

Since the redox-potentials of the colloidal particles in contact with $A^{=}$ solution, which have oxidation reduction potentials are the same as the redox-potential of $A^{=}$ solutions at the same *p*H value and at the equilibrium concentration of $A^{=}$ solutions, the adsorption and desorption of the $A^{=}$ ions must be the same and cataphoretic velocities of the colloidal particles must be the same.

From the theory developed above it follows that in presence of different concentrations of electrolytes at different *p*H values, provided the electron ion activity, *i.e.*, E_{redox} and k the dissociation constant of the electrolyte remain constant, the absolute values of the cataphoretic velocities should be the same assuming that the cataphoretic velocity depends on E_{redox} alone.

Ghosh and Basak's[1] results show that the absolute values of the cataphoretic velocities are close to one another when dissociation constants k of the dyes 'AH_2' and the electron ion activities, *i.e.*, the redox potentials are close to one another.

S. G. Chaudhury

Department of Chemistry,
University College of Science,
92, Upper Circular Road,
Calcutta, 7-12-1944.

[1] Ghosh and Basak, *J. Ind. Chem. Soc.*, *17*, 721, 1940.

"Give Science a Chance"

Sir Shanti Swarup Bhatnagar's General Presidential Address at the Indian Science Congress, Nagpur

Introduction

I am deeply grateful to the Indian Science Congress Association for the great honour they have conferred upon me by electing me as their President for this year. I had considerable diffidence in accepting this high distinction, particularly as after my election I received an invitation from His Majesty's Government to visit Great Britain, and I was not certain whether I could return from this trip and a subsequent visit to the U. S. A. in time to be able to preside over the annual general meeting in Nagpur in January 1945. I was, however, assured by the Government of India in April last that I would be able to return in good time to preside over the session of the Indian Science Congress, and that I should not refuse an honour which is offered only once in one's lifetime. My colleagues who have been visiting England and the U. S. A. with me advised me to send the Presidential Address in good time, so that it could be read on my behalf by some one else in case I was unable to reach India in time to preside over the meeting on the 2nd January 1945, and they strongly dissuaded me from resigning the Presidentship. Several happenings, however, particularly the events connected with D-day and the advent of flying bombs and rockets, unfortunately so much delayed our visit to England that it now seems almost certain that I shall not be able to be present with you in body at the time of the general meeting. I shall, however, be present in spirit and I hope under the able management of the local secretaries at Nagpur and the secretaries of the Indian Science Congress Association the session will be celebrated with the usual dignity and keen interest. I am fully aware of the deep interest which His Excellency the Governor of your province has taken in making this session a great success. It is a great disappointment to me that I am unable to take advantage of His Excellency's gracious offer of hospitality during the session.

Before I begin my address I must refer to the sad loss which our country and the world of science has suffered by the passing away of our great Acharya Sir Prafulla Chandra Ray. He was President of the session when the Indian Science Congress first met at Nagpur in 1918. Men of his type are not born every day and our motherland will not easily recover from the shock caused by the death of a son so highly distinguished for his scientific achievements and patriotic services in many fields.

Visit of Professor A. V. Hill

Perhaps the most outstanding event in the scientific life of India during the past year was the visit which Professor A. V. Hill, Nobel Laureate and Secretary of the Royal Society of London, paid to us at the request of the Government of India. The invitation to Professor Hill has been generally taken as an indication of the interest the Government of India is taking in securing the aid of science in problems of national development to which they are committed during the post-war period. It was largely owing to the insistence of the Council of Scientific and Industrial Research that more financial aid should be given to science, that such an invitation could be conceived even during the war. One must not forget, however, the part played by Science and Culture which under the able editorship of our distinguished physicist, Professor M. N. Saha, always criticized the Government for lack of interest in matters scientific and for scanty provision of funds.

Several officials in the Government and the public outside thought they detected in this criticism motives of jealousy, as there is no doubt that the Council of Scientific and Industrial Research had achieved important results in spite of inadequate financial assistance from the Government and industries, and deserved the fullest support from all friends of science and industry. Nothing could be further from the truth than this suspicion. No more ardent supporter of science, and of national development through it, exists in India than Professor Saha and I take this opportunity of acknowledging the help I have always received from him in my lonely fights for better recognition of science in my country. Every form of unofficial support, on which alone one can finally depend for a democratic realization of the role of science in nation-building, always came unhesitatingly from him and his colleagues.

It is a happy augury that the report made by Professor A. V. Hill had an unusually short incubation period. Following his recommendations the

Government of India have already created a Department of Planning and Development and the Council of Scientific and Industrial Research has been transferred to this portfolio. Other research activities under the Government are likely to follow suit. I am sure the scientists assembled here have special reason to be happy in the fact that the choice of the Viceroy for the care of this new portfolio has fallen upon Sir Ardeshir Dalal who has been a past-president of the Indian Science Congress and who commands the confidence and respect of the scientists as well as of the business community of India. It is hoped that other far-reaching recommendations of Professor A. V. Hill will also be accepted by the Government of India. There is no better method of raising the standard of science and scientists in this country than that so ably developed and skilfully described in his address before the last session of the Indian Science Congress.

Indian Scientific Mission to U. K., U. S. A. and Canada

Another direct outcome of Professor A. V. Hill's visit to India has been that a mission of scientific workers from our country has been touring the U. K. and has arranged to go over to the U. S. A. and Canada, to observe the scientific, industrial and agricultural developments which have come about in these countries during the war and then to make recommendations and suggest plans for a further interchange of information and knowledge for mutual help and co-operation. India has been cut off intellectually for more than five years from the rest of the world and that in itself is a disaster the magnitude of which is directly proportional to the vast strides science and research have made in the U. K. and North America.

My present visit to England has been the greatest eye-opener to me and I have now seen with my own eyes the high levels to which scientific invention and ingenuity have risen during the war. Not only has science helped in developing weapons and instruments which are essential for success in a mechanical warfare, but it has aided industry and agriculture in supplying the basic needs of humanity during a period of great difficulty. The results both in military and human terms have been most encouraging. The large-scale application of radiolocation, the jet propelled planes, the numerous types of jettison tanks and unbreakable containers, the automatic weapons of offence and defence and scores of new alloys and novel metallurgical processes have had far-reaching consequences on the course of the war. The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of penicillin and D. D. T., all these have contributed much to the realization by the common man and the Government that organized science is one of the most important factors in national development. It is a tragedy that a ruthless war and almost universal bloodshed should be necessary for this new awakening, for it should have been obvious without it that science can play and must play an essential part for human advancement. In fact, unless opportunities are provided for science to explore these possibilities for human betterment, a better world cannot be created.

There is no doubt that England is sparing no effort to approach the Peace much better informed and equipped than after the last war and the signs of this new awakening are visible in the universities, the Government departments, in industry, the agricultural and medical institutions and in every other walk of life.

As representatives of Indian science, we have been welcome everywhere. The Government, the Royal Society and other learned societies, the universities, the Department of Scientific and Industrial Research and the Research Associations and the National Institutions associated with it, the agricultural and medical institutions, the clubs, the British Council and the industries and trades, the social and political organizations, the public schools and important private individuals have vied with one another to have us for teas, for luncheons and dinners and for speeches for which we have become notorious all over the country! Everyone seems to regard our visit as a prelude to better understanding and trade relationships between our respective countries and as a gesture of friendship from the British Government, British science and British industry to India. Even Ireland has not insisted upon isolation and strict neutrality and I had a most pressing invitation to address the University of Dublin on Scientific and Industrial Research in India, and this invitation was extended to my opposite number in the U. K., Sir Edward Appleton, as I pleaded that I was tied up with engagements with him and could not visit Ireland unless he also came with me. An important member of His Majesty's Government's Hospitality department told the Assistant Secretary of the Royal Society that even Kings visiting England did not receive such a warm welcome as the Indian scientists have received! All this is an indication of the keen interest people in England are taking in science and research.

Science in the British Universities

We found most universities denuded of their ablest workers. They were nearly all engaged in important war work and visited their departments

only occasionally. They were busy with meetings and committees and in special scientific work related to the war-effort: but all the same they are all devoting their attention to the future of science in British universities. The Association of Scientific Workers has submitted a memorandum to the University Grant Committee of the Treasury suggesting what reforms in teaching and research should be taken in hand immediately after the war and better provision for science should be made in the universities. Their report ends with the following strong plea:

> 'We reiterate, then, our plea for the utmost vision and flexibility in budgetting for the development of science in the universities. Where the flowering of intellect is concerned, any accurate prediction is impossible. We are convinced, however, that peace can see at least as rapid a growth in all fields of science as war has brought about in some special applications. The only proper attitude for an enlightened community is to make available the financial and material resources appropriate to each stage of development. We are far from being in sight of either the limits of science or the end of our reserves of intelligence. Bold and flexible thinking is therefore the prime necessity in framing post-war policy for the universities.'

Out of the many important recommendations made by the Association of Scientific Workers for the expansion of scientific activities in the universities, the following are quoted so that the Indian universities may take a lesson from what is now the train of thought in Great Britain:

(1) Schools of fundamental research must be fostered in the universities, expansion proceeding as fast as talent appears.

(2) All graduates with an aptitude for research should be offered full maintenance while working for a higher degree.

(3) Research fellowships should be provided for those who have taken a doctorate degree.

(4) When men are appointed mainly to do research they should have to have the same status and salary as those appointed mainly for teaching.

(5) Research committees should be set up in every university to watch over the development of research, especially in borderline subjects, and prepare an annual research budget.

(6) The education and training of laboratory technicians should be given immediate attention. Courses should be planned for general education and technical training.

(7) The wages of technicians must be revised upwards forthwith if the universities are to attract the right type of personnel.

(8) Centralized technical services and supplies for research should be established in each university. These should include facilities such as a typewriting pool and a statistical service.

(9) Departments of applied science should be brought into being, as they are bound to play an important part in the university.

(10) Industrial development work should be carried out in Research Association laboratories: but where these Research Associations do not exist the university laboratories may be employed.

(11) Academic scientists should be allowed to act as consultants or advisory directors of research to research associations and should be given leave to spend long vacations in industrial laboratories.

(12) Properly supervised research in selected Research Associations and Government laboratories should be allowed as part of or a full qualification for a higher degree.

Some of these recommendations involve capital cost and the memorandum referred to above estimates this to be not less than £30 million over a period of ten to twenty years. The actual expenditure of the universities would rise to £15 million per annum with five years and to £30 million over ten years at 1939 values. It has been suggested that most of this money will come from the State. Further, it has been strongly recommended that the Treasury Grant to the Universities should be doubled in the first academic year after the war and increased to quadruple, that is to £6 million, in the fifth year.

The future of science in the British universities would thus be assured. This must serve as an incentive to our Vice-Chancellors who should ask the nation and Government for more grants for technical education and development of sciences in the Indian Universities. I have been told that at least in two Universities in India, scientific research is now positively discouraged and (in the name of economy) admission to research students, in spite of the willingness of the professors concerned, is almost completely prohibited. I take this opportunity of drawing the attention of those who love their country and wish it well to see that the field of university education is kept as free from narrow communalism and politics as possible. Since politics has begun to play a part in the selection and election of Vice-Chancellors, the University standards in India have tended to deteriorate instead of showing an improvement and if these evils are not looked into by the Chancellors and the Courts of the Indian Universities, these institutions will cease to be real seats of learning and will turn into arenas for political ambitions.

Science in British Industry

British industry in the past relied too much on tradition. It is now realised that the prosperity of Britain after the war will depend as never before upon the efficiency and progressiveness of her industries. Happily, for it is a most healthy indication of things to come, industrial and scientific research, is on almost everyone's lips now-a-days and it is certain that this will be one of the major features in post-war industry. In certain industries, such as the chemical industry, the application of science and research has reached such high levels already that even the Department of Scientific and Industrial

Research has not considered it an imperative necessity on their part to equip and maintain their Chemical Research Laboratory to the same level of efficiency as their National Physical Laboratory. They maintain that the Imperial Chemical Industries conduct research on such a large and liberal scale that the Government Laboratories need not compete with them. The Directors of the Company are progressive in their views on scientific development and at a luncheon which the I. C. I. gave to the Indian scientists at Claridges, Lord McGowan, the Chairman, reported that the Directors of the Company had offered to provide at nine Universities of Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in certain sciences. The research organisation of the Company itself consists of nearly nine hundred fully qualified chemists, physicists, biologists, engineers and other scientific men and more than a thousand skilled assistants. During 1943 its expenditure on research and development in its own work was approximately £2,200,000 ; and in addition, £12,500,000 became due from the Company to the British and Overseas Governments under the heading of Excess Profits Tax, National Defence Contribution and income-tax. We had the good fortune to see their vast factories and research organisations at Billingham, Blackly and Huddersfield, and our distinguished industrialists who are visiting England should go and see these signs of research-mindedness of the British industries.

When I replied to the toast proposed by Lord McGowan at the luncheon, I spoke of the I. C. I.'s partiality to their own country. They had at least two big factories in India and I pleaded for grants on a generous scale for scholarships for scientific research in India by the I. C. I. I urged that no feast given to the Indian Brahmins is complete without a gift, and that all scientists are Brahmins by profession. The plea went home to Lord McGowan and he promised to consider in a friendly way the question of endowing research fellowships in Indian Universities. He also assured us that the eighty fellowships in the British Universities were open to Indian scientists in free competition.

Besides the I. C. I., there are other industries in Britain which have large research departments, and we were particularly impressed by the efforts which had been made by such firms as Metropolitan Vickers at Trafford Park, Manchester, by the General Electric Company at Wembley, by Burroughs Welcome, by Brown Firth & Co., by the B. T. H. at Rugby and by the Anglo-Iranian and Shell group organisation. In addition to the many private investigations carried out by individual firms, the interests of research by industry are safe-guarded by investigations carried out in twenty-four Industrial Research Associations, which are maintained jointly by Industry and the Department of Scientific and Industrial Research.

We are aware of even more outstanding organisations of this kind in the U. S. A. and Canada and look forward with eagerness to visiting the Bell Telephone Laboratories in New York in which the American Telegraph and Telephone Company employ over 4,000 scientific workers and technical men. The General Electric Company at Schenectady, N. Y., the Eastman Kodak Company at Rochester, N. Y., the Mellon Research Institute, Pittsburgh, and the various Petroleum Companies in the U. S. A. have fully equipped laboratories which work day and night on problems of fundamental and applied interests.

If Indian industry has to rise, and rise it must to its proper stature in time, it must begin to devote more attention to expenditure on research. There is hardly any industrial organisation in India except Tatas which provides even reasonable facilities for scientific and industrial research. Lately Mr G. D. Birla and Sir Shri Ram have shown some interest in scientific research, but much has yet to be done by science to save the existing industries in India from extinction by outside competition after the war.

The newly started industrial units of India should join together and form Industrial Research Associations and the Council of Scientific and Industrial Research and the Government should subsidise the organisations so that they may blossom forth into hopeful industries of the future India.

Now that expenditure on research, both capital and recurring, is likely to be free from the Excess Profits Tax, Indian industry should give a real impetus to science. Nothing will help industry and science more than if our firms in India become research-minded. Even before my visit to England I strongly advocated the formation of Research Associations in India and I am glad to hear that the chemical and pharmaceutical industries of India are about to give a lead in this matter and have apprised the Council of Scientific and Industrial Research of their intention to form a research association. After seeing the work of Research Association Laboratories here, I have become convinced that we must work hard to get our small and big industries in India research-minded so they may gain knowledge and strength to produce goods of the best quality and performance.

Industrialization of India Essential for World Progress

Perhaps the most important factor which will have world wide implications will be our attempt to raise the standard of living in India. Politics does play an important part in all events. It is obvious that the best and quickest way of bringing about

national development is for India to have a National Government representative of the people. The present absence, however, of such a Government does not justify that the thinking men and women of India should not devise ways and means of bettering the lot of their fellow-beings to the best of their ability under present circumstances and in view of the future. I am not convinced that the rich and the wise in the land have done all they can for agricultural and industrial development of India.

It has been urged by some that the problem of India is largely biological, that health, food and population are our real bottle necks. Those who know India intimately are fully aware of the facts that attention to agriculture alone cannot solve the problem of India's poverty. Biology must be helped by physics, chemistry and engineering, even by mathematics. India cannot be healthy, prosperous and self-respecting, and education, medicine, and agriculture cannot play their impotrant role, unless a good bit of India's population is devoted to pursuits other than agricultural.

In a previous paper I have described the orders of priority for some of the industries essential to India's development. .In that paper the first place was given by me to the development of power and there seems to be now a general concensus of opinion that India must develop her hydro-electric and other power resources as her coal resources are already severely strained. This project will have to be largely financed by the State, as it is far too big for any private enterprise in India. The State will also have to help big basic industries and heavy engineering. We should, by all methods of persuasion and even threats, appeal to the existing industries in India to develop the bye-products industries associated with them. For example, the great jute industry in India should take immediate steps to manufacture such things as jute-boards, Prattice cloth, jute felt from jute waste, jute containers, and jute cloth for wearing purposes. The State and the public should insist upon these industries being developed by the jute industry itself. Similarly it should be the duty of the sugar industry that their bye-products such as molasses and bagasse should not be used wastefully as at present. Power alcohol furfural and its derivatives, acetic acid and all sorts of plastics and solvents can be made from these bye-products and these should occupy the immediate attention of the promotors of our sugar industry. They have sufficient money to invest in these ventures which may not start paying dividends all at once, but they will eventually be all very worth-while in national planning and development. If I would not be misunderstood, I would make a suggestion to those European and Indian friends who are interested in the industrialization of India not to fight for less or more to either side, but to come to terms honourable for both and do something to help Indian industry. It is obvious that European friends in India will have to yield to the natural aspirations of India, namely, that industry in India should be largely managed by Indians themselves. Indian businessmen should see that co-operation with the allied powers is the quickest method of developing India. The energy spent in fighting may be better spent in co-operative development. If the bye-product industries of coal-distillation, the petroleum industry, the textile industry, the woollen, cotton, sugar and jute industries and the metallurgical and chemical industries are developed, the country will have a different complexion altogether and a co-ordinated programme of development in all directions will become a possibility. This plea I am entitled to make as President of the Indian Science Congress, as I am convinced that science has no future in India unless its agriculture and its industries are fully developed: more food and more health are dependent upon these factors. Scientific and industrial research thrives best when it is applied to material benefit to human kind and to existing industries and existing agricultural enterprise.

Legislation and Scientific and Technical Progress

We were invited to a luncheon at the House of Commons by Captain L. Plugge, M.P., and were later invited to a meeting by an influential unofficial organisation known as the Parliamentary and Scientific Committee. This body consists of a large number of members of both Houses of the British Parliament, together with representatives of many important scientific and technical institutions and societies. It has no official authority but it commands great influence. Its President, Lord Samuel met us at lunch and its Chairman, Mr E. W. Salt, M.P., presided over the meeting which we attended. It was a great gathering: Professor A. V. Hill himself, as M.P., introduced the members of the Indian Scientific Mission one by one and each one of us made a short speech on our special subjects. We were subjected to numerous questions of a searching nature and the Chairman assured us that, through their influence in Parliament, they will advocate the cause of scientific and industrial research and development in India. It is my considered opinion that the members of the Council of State and Assembly in India could well form such an organisation as the Parliamentary and Scientific Committee. This would keep them in touch with all the problems of modern interest such as technology, science, agriculture, food and health. They could help by talking over matters with Honourable Members privately or by asking questions on the floors of the two Houses. Such an

organization would enable our legislators to take an intelligent interest in the terrific task of reconstruction which faces our country. This would also lead them to appreciate the special rôle of scientific men in modern society.

Training of Personnel

As a result of our visit it may be possible to persuade the Government to have scientific liaison officers in Washington and London, and possibly Moscow, so that the Indian scientists and the Indian Government departments may be in touch with the rapid strides which science and technology are making in these countries. These offices will have to be staffed by scientific men of some standing in India. It is also likely that we may be able to get admission for a large number of scholars and technicians from India both in the Universities and industries. We found many Universities eager to have good students for post-graduate studies. Lord Eustace Percy was particularly anxious that good-class Indian students should take advantage of medical and dental studies in their well-equipped faculty of medicine at Newcastle. Similar assurances were given to us by the authorities of Cambridge, Oxford, London, Sheffield, Leeds, Glasgow and Manchester Universities. There will be a great paucity of space immediately after the war in these places of learning, but they hope to have a great deal more space later on. We should increase the availability of technical talent in India by sending our young and brilliant students to England and America. India needs not only scientific researchers but also technicians persons of the foreman type who can help in the running and repairs of machinery so essential for industrialisation. Such firms as the Imperial Chemical Industries, Metropolitan Vickers and the non-ferrous metal industries in England are quite willing to train young men from India and even pay them as apprentices: we need a very large number of men with these qualifications, and we shall have to look for such training in Canada and the U. S. A. as well.

Factory and Farm

In England great emphasis is being laid on equalising the standard of life in the cities and the villages. Agriculture still retains in England too much of its primitive character. Modern methods of application of energy on the farms, conditioned transport and proper storage of agricultural porduce are still in their infancy. Canada and the United States are ahead in this field and the tractor, the motor vehicle and electric power have contributed a great deal in those countries for a better standard of life on the farm. On a value basis at present about 88% of the world's agricultural produce is used as food, 8% as textiles and 4% for other industrial purposes. The last two together form roughly one-third of the raw materials of industry. There is an increasing tendency to look to agriculture for a larger proportion of these raw materials, but these materials can only be used profitably if the factory becomes an adjunct of the farm. Industry is moving towards that ideal particularly in the U. S. A., and this may be a lesson which we in India may learn in our planning for the future. We are so primitive in our farming that this would be an idle dream unless we first improved our transport and communications and provided better methods of storage and marketing, power-driven machinery and the use of proved fertilisers.

After studying the great strides which science has made in England, we are expecting to visit the U. S. A. and Canada. As a young boy, my classmates used to tease me for being a day-dreamer. I used to think of great things which science could do for India and the part I, myself, should play in it with the rest of my friends. The improbabilities of my dreams coming true used to be the principal subject of jokes when I was a student. If I had no possessed a sense of humour and had taken those jests seriously I should have been a physical wreck. But, God be thanked, I have survived to see some of my dreams fulfilled. Failures have been many and successes rather few, but with an inborn optimism and faith in my country's future I pursue on. We shall now go from Billingham, Leeds, Sheffield, Coventry, Lancashire, from the Royal Society of London and from our beloved Hill and Dale to the land of Niagra Falls, the Boulder Dam and the Tennessee Valley. The tale of the Tennessee Valley is the romance of a wandering and inconstant river, now become a chain of charming and lovely lakes which have contributed much to the enjoyment of life of the people, on which move, without any dangers of accidents, barges of commerce which nourish American industries. It is a fairly story of wild waters controlled by human ingenuity creating electrical energy which has been America's Alladin's lamp.

I dream of the Tennessee Valley, but not without hope: for all this may happen to any river valley in India, to the Damodar, to the Ganges, to the Sutlej, to the Nurbedda, to the Sone, if the people and the Government just give science a chance.

SHORT LIFE SKETCHES
OF THE
General President and Sectional Presidents

SHANTI SWARUP BHATNAGAR

General President

Born at Bhera (Shahpur) in 1895, Sir Shanti Swarup Bhatnagar had his early education at Dayal Singh High School and Forman Christian College, Lahore. He took his M.Sc. degree of the Punjab University in 1919 and proceeded to England as Dayal Singh Scholar to work in the laboratories of Prof. F. G. Donnan, F.R.S., of the University College, London. He carried on important investigations in the field of Colloid Chemistry, which brought him early distinction in the shape of a personal grant of £250 by the Privy Council, Department of Scientific and Industrial Research. In 1921, he was awarded the D.Sc. degree of the London University in recognition of his work on emulsions and emulsification. He worked for sometime at the Kaiser Wilhelm Institute in Berlin and at the Sorbonne in Paris.



On his return to India, Dr Bhatnagar was appointed Professor of Chemistry at the Benares Hindu University. In response to the invitation extended to him by the Punjab University, he became the University Professor of Physical Chemistry and the first Director of the newly created University Chemical Laboratories. Here he carried out a series of important investigations on magneto-chemistry and designed the Bhatnagar-Mathur magnetic balance, which soon earned him wide recognition.

Dr Bhatnagar's investigations in connection with the coagulation of mud at the request of the Attock Oil Company which was then faced with great difficulty in drilling operations deserve more than a passing notice. His successful researches resulting in the solution of those difficulties led Messrs. Steel Bros. & Co., to inaugurate a scheme of research on petroleum technology, under the auspices of the Punjab University, at a cost of Rs. 1½ lakhs for five years, which was later extended to ten years at a cost of Rs. 4 lakhs.

Dr Bhatnagar became the first Director of the Board of Scientific and Industrial Research, created in 1940 by the Government of India to promote industrial research in this country. With the establishment of the Council, he became the Technical Adviser of the Council and Director of Scientific and Industrial Research. The great progress this Government organization on industrial research has made during the last four years is largely due to his untiring energy and superb organizing abilities.

Professor Bhatnagar was honoured with the title of O.B.E. in 1936 and knighted in 1941. He was elected to the Fellowship of the Royal Society, London in 1943, a singular honour accruing for the first time to an Indian chemist. He is a Fellow of several universities and scientific societies. He has held the position of the President of the Indian Chemical Society, has presided over the deliberations of the Chemistry section of the Indian Science Congress on two occasions, the last one being at the Jubilee Session, and has recently been nominated an Honorary Member of the Society of Chemical Industry, a rare distinction conferred so far on only eleven scientists of the world. He is an Honorary Professor of Chemistry at the Benares Hindu University and the Universities of Punjab and Delhi. He is the author of "Principles and Application of Magneto-chemistry", which is the first book on the subject in English, and has been highly appreciated.

B. N. PRASAD

President, Section of Mathematics and Statistics

Born in 1899 in the district of Azamgarh (U. P.), Dr Badri Nath Prasad received his education in the Patna College and the Benares Hindu University. After a brilliant school and college career culminating in a first class first M.Sc. in Mathematics in

1921 from the Benares Hindu University, he worked there as a research scholar for a year with the late Professor Ganesh Prasad and was subsequently appointed in 1922 as Assistant Professor of Mathematics. Since July, 1924, he has been on the staff of the Mathematics Department in the Allahabad University.



In 1929 he proceeded to Europe where he remained for three years. He obtained the Ph.D. degree from the University of Liverpool and *State* D.Sc. (*Tres honorable*) from the University of Paris. He studied mainly with Professor E. T. Whittaker of Edinburgh, Prof. E. C. Titchmarsh of Oxford, then at Liverpool, Profs. Denjoy, Borel and Goursat at Sorbonne and Profs. Lebesgue and Hadamard of College de France. During his stay in Europe he visited most of the important centres of mathematical researches in Great Britain, France, Germany and Italy. He was invited to read papers before the London Mathematical Society, Edinburgh Mathematical Society, Societe Mathematique de France and Mon Hadamard's Seminar at College de France. Professor Borel's remarks about the superior quality of Dr Prasad's researches are couched in highly appreciative terms ("Le Temps", Paris, June 5, 1932, p. 6).

Dr Prasad's researches lie in the domain of Pure Mathematics comprising in particular, theory of Functions of a Real and Complex Variable, theory of Fourier Series, Summability of Infinite Series, Non-differentiable functions, Fourier Integrals and theory of Conjugate Fourier series and allied topics. His long memoir on the Conjugate Fourier series (*Journal de Mathematique*, 9, pp. 153-205, 1932) has attracted considerable attention. Dr Prasad's pioneer work on Absolute Summability (A) of trigonometric series has opened a fertile field of research inasmuch as it has at once given rise to a number of papers on this subject which have been published by numerous workers in various countries. His papers have been reviewed in scientific journals in appreciative terms, and some of his results have been already incorporated in the well-known treatises on "Trigonometrical Series" by Zygmund and "Theory of Fourier Integrals" by Titchmarsh. Working under his guidance a number of research students have also published papers. Recently Dr Prasad has published a text-book on "Hydrostatics" for the use of B.A. and B.Sc. students of the Indian Universities.

Dr Prasad is a Fellow of the National Institute of Sciences of India and of the National Academy of Sciences, and a member of the London Mathematical Society, Societe Mathematique de France, Indian Mathematical Society and Benares Mathematical Society. He is connected with most of the Indian Universities in some capacity or other. At several University centres he has delivered lectures both on higher Mathematics and on popular subjects. Dr Prasad takes keen interest in University affairs inasmuch as he is a member of the Court, Academic Council, Faculty of Science and Board of Studies in Mathematics in the Allahabad University and of the Executive Council, Court, Senate etc. of the Benares Hindu University.

R. C. MAJUMDAR

President, Section of Physics

Dr R .C. Majumdar was a student of the Calcutta University and having obtained the Premchand Roychand Scholarship he went to Germany in 1930 as Carl Zeiss Fellow of the Jena University. He worked with Prof. A. Sommerfeld at Munich, Prof. H. Vogt at Jena and Prof. W. Heisenberg at Leipzig and received the Doctorate degree with Summa Cum Laude. In recognition of his works Dr Majumdar was awarded Sir Rashbehari Ghosh Travelling Fellowship for two consecutive years by the Calcutta University, which enabled him to visit and work at different Universities of Europe, particularly at the Cavendish Laboratory at Cambridge and Institute of Theoretical Physics of Niels Bohr at Copenhagen. During his stay in Europe Dr Majumdar made important contributions to statistical mechanics and astrophysics. An account of his work on relativistic statistical mechanics has been given in the book "On the Introduction to Stellar



Structure" written by Prof. S. Chandrasekhar. Dr Majumdar has recently joined the Physics Department of the Delhi University.

K. VENKATARAMAN

President, Section of Chemistry

Born on June 7, 1901, Dr Venkataraman was educated in the Presidency College, Madras and received his Master's degree in Chemistry from that University. He carried out further studies and research in the University of Manchester and received its M.Sc. Tech., Ph.D. and D.Sc. degrees. He worked under the distinguished chemist Sir Robert Robinson on problems of Organic Chemistry. He has published about 100 papers on flavones, metting agents, synthetic dyes, oxycellulose and hydrocellulose antiseptics and anthelmintics, etc. in the journals of a number of learned societies, foreign and Indian. He was Professor of Organic Chemistry, Forman Christian College, Lahore (1929-34), and reader in the Department of Chemical Technology, University of Bombay (1935-38). In 1938, he became the Mody Professor of Chemical Technology and Director of the Department of Chemical Technology in which capacity he has since then serving the University of of Bombay. He became F.I.C. in 1932 and A.M.I. Chem. E. in 1939.

N. N. CHATTERJEE

President, Section of Geology and Geography

Mr N. N. Chatterjee, in his early days, was educated in the Dhubri Government High School, Assam, and subsequently in the St. Xavier's College and in the Presidency College, Calcutta. He obtained his M.Sc. degree in 1922 from the Presidency College, Calcutta having been placed first in the first class and was awarded the University Gold Medal. He had training in coal mining for some period and in 1926 he joined the Post-Graduate Department, Calcutta University as a Lecturer in Geology and since then he has been working in that capacity. He has an intimate knowledge of the coal deposits of various places of India and has also gathered experience in several important economic mineral deposits of this country by frequent visits to those places. Mr Chatterjee has been doing research work on various topics of coal and petrology as a result of which a good number of original research papers has been published.



Mr Chatterjee has also been working as one of the Joint Honorary Secretaries of the Geological, Mining and Metallurgical Society of India.

G. P. MAJUMDAR

President, Section of Botany

Born in 1894 Professor Girija Prasanna Majumdar was educated in Calcutta. He joined the Presidency College, Calcutta in 1914, and as a part-time lecturer of the University of Calcutta in 1922. He worked under Prof. Priestley of the University of Leeds, England and has specialized in the study of the Developmental Anatomy of Plants. Dr Majumdar is a Griffith Prize holder of the Calcutta University and is the author of "Botany in Ancient India". He has edited and translated the "Upavana Vinoda",—an ancient text of Arbori-horticulture in India, and has also published a book on "Some Aspects of Indian Civilization in Plant Perspective". He is writing a volume on the "History of Botany in India" for the Chronica Botanica, Massachusetts, U. S. A. Many of his original contributions to pure botany have been published in British and Indian Journals.



Dr Majumdar is a fellow of the National Institute of Sciences of India and also of the Academy of Sciences in India He is the Secretary of the Indian Botanical Society and also its Treasurer.

A. AIYAPPAN

President, Section of Anthropology and Archæology

Dr Aiyappan was educated at the Presidency College, Madras and in the London School of Economics where he studied under the late Prof. B. Malinowski and Prof. Raymond Firth. In 1929 he was appointed Curator for Anthropology and Prehistoric Archaeology in the Madras Government Museum and was promoted to be the Superintendent of the institution in 1940. He attended the International Congress of Anthropology in London in 1934 and was nominated as one of the two national secretaries for India of the Copenhagen session of the Congress. Among his publications are *Social and Physical Anthropology of the Nayadis of Malabar, Iravas and Culture Change, The Manley Collection of Stone Age Tools (Memoirs of the Archaeological Survey of India)*, and several papers on the megalithic monuments of S. India. For the last few years he has been engaged in field work on the tribes of the Wynad Plateau of S. India. He helped also in bringing to the notice of the public and scholars the importance of the ancient town site at Arikamedu near Pondicherry where pottery of Mediterranean type has been discovered. As Chairman of the Madras University Board of Studies in Anthropology, he is helping in the organization of anthropological studies and research under the auspices of the Madras University. He is also one of the very few Indians to have obtained the Diploma of the Museums Association of London and to have undergone training in modern methods.



S. W. HARDIKAR

President, Section of Medical and Veterinary Sciences

Born on November 24, 1894, Dr Hardikar qualified as Assistant Surgeon from the Medical School, Hyderabad-Deccan in 1911. He began his career as a private practitioner and was for some time in the Government service as probationary assistant surgeon. He was awarded the Government Foreign Scholarship for study in Britain in 1916 and proceeded to Edinburgh. In 1920, he received the M.B. and Ch.B. degrees of the Edinburgh University and carried out Post-Graduate work in Pharmacology under the late Professor A. R. Cushny, F.R.S., in the same University. In 1924, the University conferred on him the degree of M.D. (Edin.) with a gold medal for his thesis on "The action of Quinine on Protein Metabolism, Respiratory Exchange and Heat Function." He was made M.R.C.P. (Edin.) in 1925. From 1922-1923, he was the University Assistant in the Department of Materia Medica and the Chrichton Research Scholar in Materia Medica and thus had the honour of being the first Indian to be on the teaching staff of the Edinburgh University.



On his return to India, he became chemical examiner to the Nizam's Government and Professor of Pathology, Osmania Medical College, Hyderabad-Deccan, in 1924. In 1926, he was Civil Surgeon, in Nalgonda and Hyderabad. He became the Professor of Physiology of the Osmania Medical College in 1928 and Professor of Pharmacology and Honorary Physician of Osmania Hospital in 1930. In 1943, he was officiating Principal of the College for a short time. In 1944, he became Vice-President of the Hyderabad Medical Council.

Professor Hardikar has been a member of several learned societies in Great Britain and in India, such as the Physiological Society of Great Britain (since 1927), British Medical Association (1924), Hyderabad Medical Association and Hyderabad Branch of Indian Medical Association (since establishment). He is one of the representatives elected by the Universities on the Governing Body of the Indian Research Fund Association. He has published several important papers in foreign and Indian medical journals.

N. V. JOSHI

President, Section of Agricultural Sciences

Prof. N. V. Joshi came from the district of Ratnagiri in the Bombay Province. He was born in 1885 at Basni, a village near Ratnagiri. His primary education was completed in the primary school

in the same village. For Secondary education he was sent to Bombay. After matriculating in 1900 he joined the Elphinstone College in Bombay and graduated in Arts with Physics and Chemistry as optionals in 1904. Next he joined the Agricultural branch of the College of Science, Poona and was the first graduate in Arts to take this course. After taking the full course in Agriculture he got the Agricultural degree in 1907. After a few months he was employed as a Demonstrator in Chemistry at the Poona Agricultural College, which was by that time established as a separate Institute, independent of the College of Science. While engaged here as a demonstrator, he studied for the Science degree with Chemistry and Geology as his subjects and got the B.Sc. degree of the Bombay University in 1908. After this, he was awarded the Mangaldas Nathubhai Scholarship by the University of Bombay ; but owing to some family mishap, he had to give up the scholarship and forgo the advantage of further education in western countries. In 1910, he was taken up as first assistant to the Imperial Agricultural bacteriologist at the Pusa Agricultural Research Institute. The name and prospects of this post have changed twice but he continued to hold it as assistant agricultural bacteriologist till the time of his retirement.



While in service most of his time was devoted to research work in the different branches of agricultural bacteriology, *e.g.*, decomposition of organic manures in soils, green manuring, nitrogen conservation, etc. Preservation of fruits and vegetables also occupied his attention. His work on the root-nodule organisms of the leguminous plants formed the subject of his thesis for the M.Sc. degree of the Bombay University.

He has contributed several papers at the successive sessions of the Science Congress and was recorder of the Agricultural Section of the Science Congress for two years.

After retirement from Government service, he has been recognized as a University Teacher in Microbiology and Biochemistry by the University of Bombay, and at present working as an honorary professor at the Fergusson College guiding the post-graduate students in their research work.

B. MUKERJI

President, Section of Physiology

Born at Barrackpore, 24-Parganas, in 1903, Dr B. Mukerji received his education at the Shyambazar Vidyasagar School, the Scottish Churches College and the Medical College, Bengal. After a brilliant school and college career, he obtained his 'Bachelor of Medicine' degree in 1927 from the Calcutta University with honours in Pharmacology and in Midwifery and Gynaecology, standing first in order of merit from the Calcutta Medical College. After nearly a year of resident House-Surgeonship in the Eden Hospital, he joined the School of Tropical Medicine, Calcutta, as a research worker on Indian indigenous drugs under Colonel Sir Ram Nath Chopra. Here he distinguished himself early as a keen scientist and a capable lecturer and in 1930 was selected for the post of the Assistant Secretary to the Drugs Enquiry Committee of the Government of India. In this capacity, Dr Mukerji toured extensively all over India and gained first-hand information about various problems pertaining to drug industry and drug trade in India. In 1931, he rejoined his duties as a research worker in the School of Tropical Medicine and during the next two years carried out promising investigations and published several papers on the pharmacology and therapeutics of Indian santonin, ephedra, squill, ipecacuanha, yellow oleander, narcotine, etc. On the merit of his work on the Pharmacology of 'Indian Indigenous Drugs' he was awarded in 1933 the Rockefeller Foundation Fellowship and under its auspices, he studied modern methods of advanced pharmacological and biochemical research in various seats of learning in China, Japan, America, Great Britain, France, Belgium and Germany, spending the major part of his time in America (Michigan University), London and Munich.



After his return to India in 1937, Dr Mukerji was appointed pharmacologist to the Bio-chemical Standardisation Laboratory (nucleus of the Central

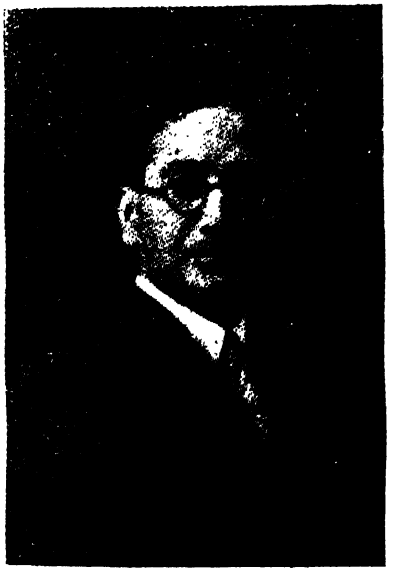
Drugs Laboratory) of the Government of India, and has since been responsible, along with Sir Ram Nath Chopra, in the proper functioning, for the first time in this country, of a drug standadrization and control laboratory, undertaking chemical, pharmaceutical, biochemical and biological assays under one roof. Since 1941, Dr Mukerji has taken over charge as the Director of the Laboratory at Calcutta and its branch at Kasauli (Simla Hills).

Dr Mukerji is the recipient of several prizes, scholarships and medals from the Medical College and the Calcutta University and is a Member or Fellow of many learned societies in India, Great Britain, Germany and America. He is associated with the post-graduate teaching of Applied Physiology and Pharmacodynamics of the Calcutta University and has served in many Governmental Committees concerned with drugs and pharmacy. He was elected a Fellow of the National Institute of Sciences of India and the American Society for Pharmacology and Experimental Therapeutics between 1941-1943.

A. N. KHOSLA

President, Section of Engineering and Metallurgy

Born in December 1892 at Jullundur in the Punjab, Rai Bahadur A. N. Khosla had a distinguished career both at school and college. He graduated from the Punjab University in 1912 and topped the list of successful candidates. He received his technical training at the Thomason Civil Engineering College, Roorkee, from where he passed out in 1916 with high distinctions both in sports and studies.



He joined the Punjab Irrigation Department in September, 1916, and was employed on the Bhakra Dam Surveys. He served with the Mesopotamia Expeditionary Force during the last Great War in Mesopotamia and on return home was engaged for over 4 years on the construction of the Suleimanke Headworks. He was then posted to the Marala Headworks where he initiated his studies on sub-soil water flow in relation to the stability of structures resting on permeable foundations. These studies were continued by him at Punjab Headworks where he was previously able to instal a large number of pressure observation pipes. In this period he wrote several papers on the subject for the Punjab Engineering Congress which won for him the Congress Medals for the years 1930 and 1936 and the Kennedy Memorial Medal for the year 1936.

Subsequently he was employed on the reconstruction of the Khanki Weir. On completion of this work (1936) he was able to write his *opus magnum* "The Design of Weirs on Permeable Foundations", which introduced a new theory of sub-soil flow under masonry structures and which has now replaced all old theories on the subject. This he did jointly with Drs Bose and Taylor. This was published by the Central Board of Irrigation and won for Mr Khosla an international reputation as well as the Kennedy Memorial Medal for the second time.

The biggest and the most important engineering work so far constructed by him is the Headworks of the Haveli canals at Trimmu which he completed in a period of about two years—a record achievement for a work of this magnitude. The design of this work is wholly based on the theory and principles enunciated in his "*opus magnum*".

The Punjab Government deputed him to the United States of America, Canada and other countries of the world to study the technique of the design and construction of high dams in 1931 and again in 1939.

In August, 1943, he was appointed Chief Engineer and is since then engaged in the preparation of projects for the construction of three major dams for storage and hydro-electric development in the Punjab, two of which dams will be almost as high as the Boulder Dam—the highest dam in the world.

NAGPUR AND ITS SURROUNDINGS

THE Indian Science Congress Association will hold its 32nd Annual meeting at Nagpur, under the auspices of the Nagpur University, in January, 1945 and will be presided over by Sir Shanti Swarup Bhatnagar, F.R.S. The congress previously held its sessions at Nagpur in 1920 and 1931, presided over by the late Sir P. C. Ray and Lt.-Col. R. B. Seymour Sewell, I.M.S., respectively.

Nagpur, a district in the Central Provinces (3,840 sq. miles) lying between 20°·36′ and 21°·43′ N and 78°·17′ and 79°·43′ E is bounded on the north by Chhindwara and Seoni, on the east by Bhandara and on the south and south-west by Chanda district and river Wardha. The sudder station, Nagpur has a municipal area of 4 sq. miles.

Legendery Period

According to tradition, Nagpur was included in the kingdom of Ajodhaya, when the divine Rama ruled over it. The Ramayana recounts how Rama traversed the forest of Dandaka, extending from the Jamuna to the Godavari river on his way to the hermitage of Sutikshna at Ramtek.

The Ahiras (4-5 century A.D.)

The oldest architectural remains in the district are believed to be the circles of stones which are found in a number of villages.

These were constructed by an unknown race but are ascribed by the people to the pastoral gaolis or Ahirs. Fragments of pottery, flint arrow heads, iron implements, evidently of great antiquity have been found beneath these stones, that are said to be the encampments or burial places of Gaolis. According to Hislop these are vestiges of a race of nomad shepherds—a branch of the Scythian tribes, who overran India from the Central Asian steppes in the 4th and 5th century A.D. The remains of the fort of Parseoni are also ascribed to the Gaolis and the calendar in common use in the Marattha districts is named after them.

Vakataka Dynasty (6th Century A.D.)

Little is known of this Rajput dynasty, whose dominions included the Satpura and Berar.

Shail Kings (8th century A.D.)

From an undated copper plate and on paleographic grounds which is referred to the 8th century, a line of kings who possessed the whole of Vindhya is traced. Their family name was *Shail* which means "a mountain".

The Rashtrakuta Dynasty (750 A.D.–1000 A.D.)

This dynasty dates from 750 A.D. A copper plate found at Deoli in Wardha, dated 940 A.D. indicates the reign of the King Krishna III and even at this period Nagpur gave its name to a district, which included Wardha and South of Chhindwara. The supremacy of the Rashtrakutas (Rathor Rajputs), lasted for about two centuries and during their pre dominance the Kailasa temple at Ellora was built. This period was remarkable for the bitter rivalry of Hinduism and Jainism—Buddhism being a declining religion in the Deccan.

Ponwar Kings (11th Century A.D.)

By the end of the 11th century, Nagpur country appears to have passed out of the hands of the Rashtrakutas, into those of Ponwars of Malwa. Their territories extended to Berar and the Godavari and even to the Carnatic. The existing Ponwar caste of Nagpur are a relic of this dynasty.

Gond Princes—Jatba (16th Century A.D.)

Nothing is known definitely about the history of Nagpur from this time until the rise of the Gond* Kingdom towards the end of the 16th century. Deogarh, the headquarters of the old Gond dynasty of Chhindwara and Nagpur is a fortress about 24 miles south-west of Chhindwara and picturesquely situated on a crest of the hills.

The semi-mythical Gond hero, Jatba, founder of this dynasty is said to have built the Deogarh fort. But according to local tradition, Deogarh was originally a Gaoli Kingdom, and later conquered by the Gond King, Jatba, being eighth in descent from the founder of the dynasty. It is said Emperor Akbar came to Deogarh when Jatba ruled and the latter visited Delhi. The existing remains at Deogarh are in the Muhammadan style, and were no doubt constructed by Bakht Buland.

Bakht Buland (1700 A.D.)

Bakht Buland was the 3rd or 4th in descent from Jatba. The prince entered the services of Emperor Aurangazeb at Delhi. He gained the favour of the Emperor, who induced him to adopt Muhammadan faith, and was acknowledged as Raja of Deogarh under the name Bakht Buland. He appreciated the advantages of the civilization which he witnessed at Delhi and determined to set about the development of his own territories. To this end he employed,

* The name "Gondwana" in Geology is derived from the "Gonds" as these formations were first known from the Narbaddas and later discovered in other parts of the Southern continent, *viz.* "Gondwanaland". The name was first introduced by H. B. Medlicott in 1872 and later revived by O. Feistmantal (1876).

Hindus and Mussalmans of ability and agriculture and industries made considerable advances.

Much of the success of the later Marattha administration was owing to the ground work established by him. He extended his territories and established the modern city of Nagpur.

Fall of Deogarh Dynasty (1743 A.D.)

Bakht Buland's successor Chand Sultan removed his capital to Nagpur, which he made a walled town. Continuance of the liberal policy of his predecessor, led to increased wealth of the country. On Chand Sultan's death in 1739, an illegitimate son of Bukht Buland usurped the throne. Chand Sultan's widow invoked the aid of Raghuji Bhonsla, who was governing Berar, on behalf of the Peshwa—in the interests of her sons. Raghuji, on being called in by the contending Gond factions, replaced the two sons of Chand Sultan on the throne from which they had been ousted by an usurper and retired to Berar with a suitable reward for his assistance.

This was the first direct connection of the Bhonsla family with Nagpur. Dissensions however broke out between the brothers in 1743. Raghuji again intervened at the request of the elder brother and drove out his rival and he took all power into his own hands. Burhan Shah, the Gond raja, though allowed to retain the outward insignia of royalty became practically a State prisoner and all real power passed to the Maratthas.

The Bhonslas—Raghuji I (1743–1755)

Bold and decisive in action, Raghuji was a perfect type of a Marattha leader and was the first and most distinguished of the Bhonsla rulers of Nagpur, where he reigned nominally as the representatives of the Gond prince from 1743 to 1755. He saw in the troubles of other States an opening for his ambition and did not even require a pretext for plunder and invasion. Twice his armies invaded Bengal and he obtained the cession of Cuttack Chanda, Chattisgarh and Sambalpur. He died in 1755. The countries under his dominion or paying him tribute extended east and west from Bay of Bengal to the Ajanta hills and north and south from the Narbadda to the Godavari.

The reign of Raghuji I is important in the history of Nagpur, because with him came an influx of different Marattha tribes, which altered the face of the country, the administration as well as the language of the people.

Janoji (1755—1772)

Raghuji was succeeded by his son Janoji, to the sovereignty of Nagpur. He and his kingdom became relatively stronger than other Marattha provinces. He took part in the wars between the Peshwa and Nizam and after he had in turn betrayed both of them, they united against him and sacked and burnt Nagpur in 1765. He died in 1772. During his reign the country of Nagpur, except on two occasions had perfect peace.

Madhoji (1772—1778)

After Janoji's death, his brothers fought for the succession until one shot the other on the battlefield of Panchgaon, 6 miles south of Nagpur. Madhoji succeeded to the regency, on behalf of his infant son Raghuji II, who was Janoji's adopted heir. In 1785, Mandla and the upper Narbadda Valley were added to Nagpur by treaty with the Peshwas.

Madhoji the regent courted the favour of the British and he assisted the march of British troops through his province, when a force was being sent from Bengal against Haidar Ali. The regent died in 1788 leaving the Nagpur State in a state of tranquility and prosperous conditions.

Raghuji II (1778—1816)

Raghuji II, now assumed charge of the State and took up his residence at Nagpur. He ceded several districts and forts and the Nagpur kingdom was now at its greatest extent and included practically the whole of the present Central Provinces and Berar, besides Orissa and some Chotanagpur States. Up to 1803, Marattha administration was on the whole successful.

During this time, the connection of Nagpur with the British Government had been growing firmer and in 1798 a British resident was appointed to the court of Raghuji, who had to withdraw in 1803 from Nagpur as Raghuji united with Scindhia against the British Government. The two chiefs were however, decisively defeated at Assaye and Aragaon and by a treaty of Deogaon, Raghuji ceded to British Cuttack, Southern Berar and Sambalpur. Nearly one-third of the Kingdom of Raghuji was shorn off and the Raja had to receive permanently a British resident at Nagpur and Monstuart Elphinstone, the eminent historian, was appointed to the post.

A period of misrule prevailed from 1803-1818. Raghuji attempted to make up the loss of revenue from the remainder of his territories and many new taxes were imposed. The pay of the troops was in arrears and they maintained themselves by plundering cultivators. At the same time, commenced the raids of the Pindaris, who became so bold that in 1811, they advanced to Nagpur and burnt the suburbs. It was at this time that most of the numerous village forts, were built,—remains of which stud the whole district,—to which on the approach of these marauders the peasant retired, and fought for bare life, and all they possessed outside the walls, being lost to them.

On the death of Raghuji II in 1816, his son Parsoji, an imbecile succeeded to the throne, but he was soon supplanted and murdered by the notorious

Madhoji or Appa Saheb, the son of the late Raja's younger brother.

A treaty of defensive alliance providing for the maintenance of a subsidiary force by the British was signed this year, a resident having been appointed since 1798.

Appa Saheb (1816—1818)

In 1817, on the outbreak of war between the British and the Peshwa, Appa Saheb threw off his cloak of friendship and accepted an embassy and title from Peshwa. His troops attacked the British and were defeated in the brilliant action at Sitabaldi and for a second time round Nagpur city.

The hill Sitabaldi, (Fig. 1) consists of two eminences, joined by a narrow neck of ground of lower elevation. The British troops occupied these positions and succeeded in resisting the onset of the Maratthas.

The regent demanded unconditional surrender of the Raja and the disbandment of his troop. Appa Saheb feigned to surrender and when the British advanced to take possession of guns an action took place, over the ground lying between the present jail building and Sakandara gardens. The Maratthas were totally routed.

As a result of these battles, the remaining portion of Berar and the territories in Narbadda valley were ceded to the British and an engagement was drawn up, re-instating Appa Saheb on the throne.

Shortly afterwards, it was discovered, Appa Saheb was again intriguing and was deposed and forwarded to Allahabad in custody. On the way, he corrupted his guards and managed to escape in the dress of a Sepoy first to Mahadeo hills and subsequently to the Punjab. He died in Rajputana in 1860.

Raghuji III (1818—1853)

On the final deposition of Appa Saheb, in 1818, a grand child of Raghuji II, was placed on the throne. He was recognised as Raja Raghuji III, on the terms granted to Appa Saheb in 1816. During the Raja's minority, the State was administered by Baka Bai, the widow of Raghuji II, under the British resident till 1830. The young raja was actually permitted to assume government from this year and all these years was a period of tranquility.

Raghuji III died in 1853, without heirs, and Marquis of Dalhousie, the then Governor General, applied his policy of the "Doctrine of Lapse" and declared that the State of Nagpur has lapsed to the paramount power.

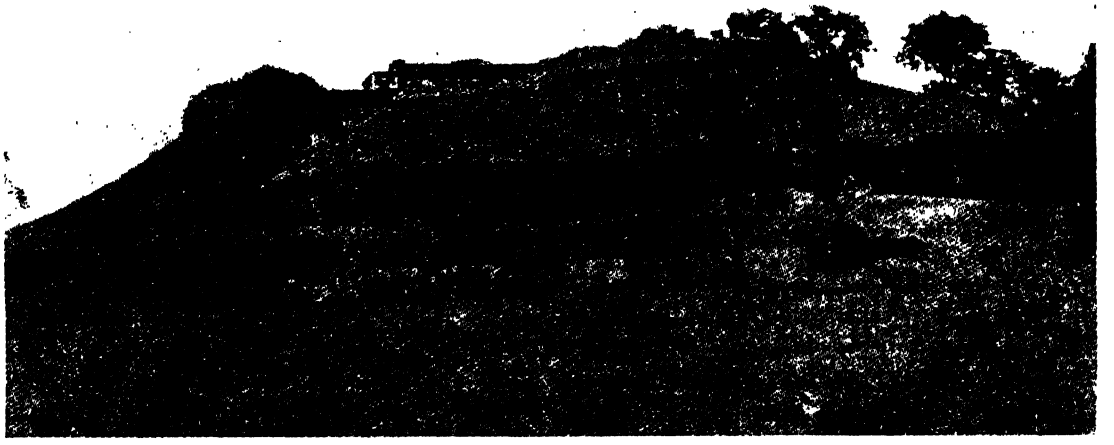


Fig. 1. Sitabaldi Hill and Fort.

British Rule (1853—1861)

During this period the dominion of the Bhonslas were administered by a Commissioner of the "Nagpur Province" and the even course of affairs was broken by events connected with the mutiny at Nagpur.

During the mutiny a scheme for a rising was formed by a regiment of irregular cavalry in conjunction with the disaffected Muhammadans of the city but was frustrated by the prompt action of the civil authorities, supported by Madras troops from Kamptee. Some of the native officers and two of the leading Muhammadans of the city were hanged from the ramparts of the fort and the disturbances ended.

The aged Bhonsla princess, Baka Bai, exerted all her influence on the side of the British and did her

utmost by her example to keep the Marattha districts loyal.

The formation of a new province *viz.*, Central Provinces took place in 1861 and this actually represented the Bhonsla kingdom at its greatest extent. From 1901 till 1920 they were governed by a Chief Commissioner, and in the latter year became a Governor's province.

In 1903, Berar was transferred by a treaty by the Nizam of Hyderabad to the British Government, and granted a perpetual lease of the assigned districts of Berar, as he was often irregular in paying the money he owed to the Company for maintaining a British contingent in his State. Berar still remains a State territory.



Fig. 2. Temples on Ramtek Hill.

Archaeology

The oldest remains in the district are the circles of rough stones found in a number of villages, already referred to in the beginning of this article.

The most important architectural monuments are the temples (Fig. 2) of Ramtek, 24 miles north-east of Nagpur by road and lies round the foot of a detached hill. The name signifies "the hill of Rama". On the hill, standing about 500 ft. above the town are a number of temples, the most important being the shrines of Rama and Lakshman on the crest of the hill and the latter contains an inscription of 14th century. The whole area within a radius of 10 miles of Ramtek is held to be holy and there are *Asht tirtha* or eight sacred places which are all visited by most pilgrims. The temple with the citadel at Ramtek is of great archaeological and historical importance.

The temple at Parseoni belongs to the Jains and there are also a few traces of Buddhist buildings.

Several villages contain the ruins of old forts. In the Nagpur museum there is a collection of sculptures obtained from several districts including inscriptions engraved on stone slates and copper plates. Among them is the Sitabaldi sanskrit inscription of the 11th century, recording the fact that Nagpur was then held by Ponwar rajas.

Some Muhammadan tomb stones with Persian inscriptions removed from Sitabaldi fort are also found in the museum.

Near the flag staff on the ground of Government House lie the bronze guns with Persian inscription, which have been brought from Asirgarh. The inscription indicates that the gun was made in 1663 A.D. in the reign of Muhammad Husain Arab.

Geology

The primary formation of the rock is sandstone, associated with shale and limestone. The sandstone is now covered by a trap and broken up by granite. This juxtaposition of trap, sandstone and granite rocks invests the Geology of Nagpur with special interest. It is also of interest as it is one of the great manganese producing centres of the world. There are also well developed coal, bauxite, fuller's earth, iron ore, laterite and ochre.

Forests and Vegetation

Forests are mainly situated in a large block on the Satpura hills, while isolated patches are dotted near the hills. The forest growth varies with the nature of the soil—*Terminalia tomentosa, Buchanania latifolia, Diospyros tomentosa* being characteristic on the heavy soils and *Tectona grandis* on good well-drained slopes and *Boswellia serrata* on the steep hill sides and ridges. The forests yield a substantial revenue, by the sale of timber, firewood and from grazing. One-fifth of C. P., excluding the feudatory States is Government reserved forest.

Being one of the hottest places in India, Nagpur does not exhibit a luxuriant vegetation. The presence of large water reservoirs around the city, a rainfall of about 50 inches during monsoon and characteristic geological formation met with in the area, render the place interesting from the standpoint of a botanist.

The typical formations (plant communities) met with in this locality are as follows ; (*a*) Black clay soil vegetation, (*b*) Trap soil vegetation, (*c*) Hedge vegetation, (*d*) Waste land vegetation, (*e*) Aquatic vegetation, (*f*) Marsh vegetation, (*g*) Dried mud or pit vegetation.

The area belongs to the Deccan region of Hooker and the dominant elements in its distribution are the *Malayan and Australian* (?). There are about 76 endemics and the number of introduced plants is about 34.

Agriculture and Industry

Agriculturally, the province is of special interest in that it is the meeting place of three great staple crops of India—wheat, rice and cotton. Black cotton soil cover Berar and parts of C. P. and this soil is best suited to grow deep rooted crops notably Indian strains of cotton which is the staple crop of this area. The remaining districts contain both wheat producing plants and extensive hills and forests. Industrially, Nagpur is a flourishing textile centre.

People and their Languages

The province is linguistically distributed between a Marhatti speaking and a Hindi speaking population. In the whole of Berar and the districts of Nagpur division, the prevailing tongue is Marhatti, in the remaining districts it is Hindi. There are a number of hill tribes, of which the principle are the Gonds, many of whom still retain their own language and their own animistic religion. In the whole province, Hindi speakers are 56 per cent., Marhatti speakers 31 per cent and Gond speakers 7 per cent of the population.

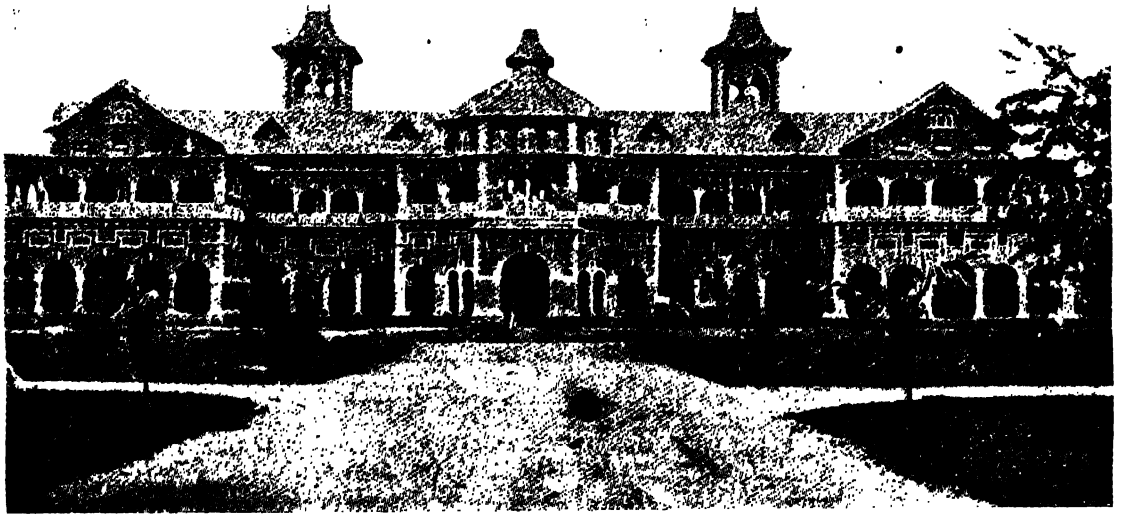


Fig. 3. Victoria Technical Institute

Educational Centres

The University of Nagpur was inaugurated in 1923 and the College of Science was opened in 1929. There are facilities for study of applied science as a result of the very generous bequest made to the University by the late Rao Bahadur D. Laxminarayan.

Besides the University has affiliated to it the old colleges, Hislop College and Morris College. There is also an Agricultural College, a Medical School and a Technical Institute. (Fig. 3).

SCIENCE AND CULTURE

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SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—I

RECENTLY a great deal of attention has been directed to the urgency of large scale expansion of agriculture and industry in this country as a means of improving the standard of well being of the people. Such expansion will involve, besides question of finance, importation of plants and machinery, also that of obtaining a sufficient supply of trained personnel to man the industries. It is also recognized that under present conditions of international competition no industry can maintain itself without the aid of applied research. It is, therefore, necessary to establish laboratories where such problems may be investigated and also to train up research workers of required qualifications. To meet the immediate demands for trained personnel it is proposed to send a large number of graduates from this country to Great Britain and the U. S. A. At the same time schemes are being formulated for strengthening the teaching and research departments of the Indian universities and also to open up new institutions for applied research.

This training will require provisions for (*i*) higher standard of teaching in pure and applied sciences than is available in this country at present, (*ii*) opportunity for research to a large body of able graduates, which will qualify them to hold the posts which will be available when the proposed schemes for the establishment of a large number of research institutions in this country materializes. At present attention is concentrated chiefly towards the expansion of industrial research in this country. An Industrial Research Planning Committee have been considering this question during the last few months. The Committee have already submitted an interim report in which they recommend that certain facilities should be given in the shape of remission of fiscal burdens on firms proposing to engage in industrial research. The Committee is now touring the different parts of the country with a view to acquainting themselves with the facilities available for such training and research and how far they can be utilized and expanded to meet the increased demand which will arise when the scheme recommended by the Committee is put into operation. We understand that the Committee's recommendation will include a large initial grant for equipment of university laboratories and research institutes whose services will be utilized for the furtherance of applied researches, and a recurring annual grant for the maintenance of a large number of research scholarships and junior and senior fellowships.

It is not known to us whether the Committee propose to earmark a portion of the grant for the purpose of improving the facilities for research in fundamental subjects, which it is supposed to be the function of universities to undertake. It must also be realized that industrial research is one of the means to be employed for bringing about a planned economic development of this country, whose aim is the improvement of the general well being of the people. All schemes of planned economy envisage a considerable increase not only in the output of industries but also of agriculture. The latter involve investigations on problems of fertilizers, soil erosion, forestry, plant ecology, plant diseases, animal husbandry etc. Moreover, the material well being of the people depends also upon satisfactory solution of problems of sanitation and the provision of adequate medical facilities. Further it is getting clear from a study of recent world happenings that, however great may be the advances in the industries by the application of physical methods, sustained social and

economic research is necessary to secure more effective use of the results. This will require a more equable distribution of our research efforts between the social, the biological and the physical sciences than is contemplated by our present engrossment in schemes of advancement by means of industrial research.

Thus we see that all schemes of national planning will involve, besides question of legislation, tariff, finance, priorities in the development of basic and consumption goods industries, the problem of obtaining an adequate supply of trained personnel and research workers required in all branches of science and for industry, for Government institutions and departments. It will also be necessary to provide for the supply of leaders in all walks of society competent to apply scientific knowledge to the service of industry or of the country as a whole. Lastly, it will be necessary to provide for some scheme of adult education through which alone can we hope for a society in which policies and plans based upon scientifically ascertained facts can be assured of reasoned and general support. In advanced industrialized countries of the West, as in England, it is generally accepted that "we live in a world in which science lies at the very root of the community, and a mastery of scientific thinking grows more and more indispensable for the successful practice of the arts of life. The culture of the modern age, if it is to have any meaning, must be deeply imbued with scientific ways of thought".

In this country with its diversities of religions and philosophical traditions and outlooks we are entering into a period of transition from a mediaeval state of society to one based upon mechanized industrial development. Many of us are at present prepared to accept science as an aid to industrial development, but whether we desire it or not, the impact of the industrial civilizations from the West is acting as a solvent of many of our cherished religious beliefs and social customs. It is for our philosophers and sociologists to study these problems and to suggest how it will be possible to incorporate in the essentials of our religious and ethical traditions and in our social organization, the implications of the recent views of life in this universe, arising out of the development of science. It will be generally accepted, however, that the education given in our schools and colleges must be such that every pupil receives an adequate knowledge of the principles and methods of science.

Returning to the immediate subject matter of discussion we shall in this review be concerned principally with (*i*) the place of universities in modern society, (*ii*) their function as source of supply of research workers and administrators in industry and elsewhere, (*iii*) this brings up the question of improving the status and conditions of employment of scientists and research workers employed in universities, Government laboratories and departments, and in industries. Considerations will be given to the suggestion of introducing uniformity in conditions of pay, leave and superannuation in all these services, which will enable an interchange of personnel between the different services ; it is expected that this interchange will act as a stimulant to freshness of outlook and to new ideas, (*iv*) further it has to be considered how the research work undertaken in the different kinds of organizations may be coordinated so that redundancy may be avoided and also serious gaps in the entire research front may be discovered and rectified.

As an introduction to the study of the conditions existing in this country and of proposals for improving them, it would be worth while our obtaining some idea of how similar problems on scientific education and research in relation to national welfare are being considered in Great Britain. Discussions on similar lines are proceeding in other countries, but in view of the fact that the majority of educational and research organizations in this country are based upon British practice, we shall only consider the British proposals here. Many of these proposals have been made available to us in the form of a booklet published by the Government of India and to which a preface has been written by Prof. A. V. Hill. In addition, we have a series of six leading articles published in *Nature* (August 26 to September, 30, 1944) entitled 'Scientific and Industrial Research.' The whole subject has been considered from a comprehensive standpoint. It appears to us that much of the criticisms and suggestions contained in the articles are pertinent to Indian conditions.

In these articles, a distinction has been drawn between the strategy and the tactics of research, *i.e.*, between the long term and short term aspects of the problem. The former deals with the broad lines of the research problems and the qualities they will demand in the personnel responsible for their execution. The articles have in view a society which is not organized on a totalitarian basis, in which both freedom of enquiry and of expression of such enquiry are safeguarded. Even in such a society the maximum of social good obtainable from the activities of a group of scientific workers will depend upon a measure of organized planning. The question of the degree of control of research, which it may be allowable to the State or to the industry, depends upon our views on the relation between fundamental and applied research ; it is usually in the latter type of research that the State and the industry are mostly interested. Here the following lines quoted from a letter written by Lord McGowan announcing on behalf of the Imperial Chemical Industries a scheme

for the provision of eighty fellowships in science at nine British universities will be found relevant. "Nearly three generations of experience of the administration of research have convinced us that academic and industrial research are interdependent and complementary and that it is useless to expect substantial advances in industry without corresponding advances in academic science". Thus if conditions under which fundamental research or investigation concerned purely with the advancement of scientific knowledge are found to be best promoted can once be established, we shall have advanced far in determining those under which applied research will also flourish. We are concerned with discovering the factors which stimulate research as well as those conditions which are restrictive or repressive. The community must seek first to find and train the men who have the ability and impulse for scientific enquiry and then it must create the most favourable conditions for their work and give them tools they need. A necessary link between the two aims is to secure competent direction of research. Creation of senior research fellowships in science may help to bring up men of the requisite outlook and calibre for the direction of research. It is also necessary to have in addition efficiently trained laboratory technicians in order to fully utilise the services of the qualified research workers. Attention is drawn to the restrictive effect which often terms of endowments have in depriving the investigator of his primary right of choosing a subject to be studied. Too rigid compartmentalism in science often acts as an impediment to effective team work between workers in one or more sciences. Further it is imperative that provision must also be made on the basis of relevance to social needs for the organized study of particular and urgent problems, both in the development of natural resources, as of fuel and power supply, and agriculture, and their effective utilization in the service of the community, and of nutrition and health. Such organized study must make provision not only for many lines of industrial research but for systematic fundamental research, planned so as to assist the advancement of science on an even front by filling up gaps left by individual initiative and with special regard to the border lines of science which are so often overlooked. Such organized study of sciences will inevitably lead to the study of a whole range of allied social sciences. Without adequate attention to social biology and of biological factors in human relations, to population changes and vital statistics, to psychology and allied subjects, we shall be without the basic knowledge required for the evolution of a better social order and the establishment of better human relations.

The attempt to formulate and apply an adequate strategy of research can only be possible when it receives the necessary support of the community. The problem involved is both the education of the adult community to the value and significance of scientific research, as well as the general education of the community and that not merely at the university level. But we are in the first instance concerned with the place of universities as the source of supply, both direct and indirect of the type of personnel required. We have thus further to consider the question of their place in, or relation to the organization of research. These questions we shall deal with in the next issue.

THE MAGNETIC CURRENT

S. D. CHATTERJEE,

BOSE RESEARCH INSTITUTE, CALCUTTA.

THE theory of magnetic current[1] has recently been sponsored by Prof. Felix Ehrenhaft, former Director of the Physical Institute at the University of Vienna, who now carries on his research in New York. It challenges the time-honoured concept of Magnetism as a static force, which is always associated with a magnetic dipole—unlike electric current in which electrons flow along a copper wire. The theory that magnetic current can be generated by a so-called permanent magnet, if proved correct, would mean the establishment of an entirely new source of power. It promises practical applications as far-reaching as have stemmed from Faraday's fundamental research on Electricity.

The hypothesis of electric current was founded chiefly upon three facts: the existence of electric ions, the decomposition of water (electrolysis), and the circulation of the single magnetic pole around the constant electric current. Ehrenhaft finds an exact analogy in the realm of Magnetism. His experiments appear to prove the existence of magnetic ions, the decomposition of water through magnet (magnetolysis), and a circulation of a single electrostatic charge around the constant magnetic current. In fact, by introducing the terms for the magnetic current to the equations of Electrodynamics, he makes these equations entirely symmetrical concerning H and E.

The three experiments upon which the new ideas are based may briefly be described as follows:

"Megnetic Ions" Experiment

In 1269, using a loadstone, Peter Peregrinus first demonstrated that a magnet had two equal and opposite poles. Since then, nobody has been able to detect any excess of north or south magnetism. Substituting microscopic particles of iron or other magnetic materials in a homogeneous magnetic field, Ehrenhaft finds them move in the direction of the lines of force, the direction of motion reversing with the reversal of the field. In collaboration with L. Banet, he also observes similar movements of colloidal particles of nickel in a liquid medium. These experiments lead him to conclude that there must be an excess of north or south magnetic charge on the particles. Expanding the terminology of Faraday, he calls the particles *magnetic ions*.

"Magnetolysis" Experiment

For this experiment, Dr Ehrenhaft uses the simplest apparatus. Two rods of pure Swedish iron are sealed in holes through opposite sides of a *U*-shaped tube containing acidulated water (1—4 per cent H_2SO_4). Instead of connecting the rods to the customary poles of an electric battery, he connects them to the poles of a permanent magnet. Bubbles of gases rising through both the columns are collected and analyzed. When the poles are not connected to the permanent magnet, only hydrogen is liberated according to the usual chemical interaction between the iron rod and the dilute sulphuric acid. When, however, the magnet is inserted in place, oxygen (2—12 per cent) is also liberated in both the columns, more oxygen being liberated at the North Pole. After rigorous precautions, including short-circuiting the magnet poles with a wire, so that the poles are kept at the same electric potential, Ehrenhaft concludes that the oxygen can only come from a decomposition of water by the magnet.

There is an interesting side-light to this experiment. Ehrenhaft observes a marked loss of strength (about 10 per cent in 24 hours) of the alnico magnet and attributes the same to the loss of magnetic ions that had flowed from the poles into the solution. The loss of pole strength per second gives the average intensity of the magnetic current flowing between the pole-faces in absolute magneto-static units.

"Electric Field around the Magnetic Current" Experiment

For this experiment, a small glass cell is used, fitted as before with pole-pieces of pure iron, that dip into acidulated water (1 per cent H_2SO_4), and connected by an iron wire. An electromagnet energizes the poles. From a projector, a powerful beam of light converges upon the narrow gap between the pole-pieces, and a low-power microscope mounted horizontally reveals the new phenomenon. As soon as the magnetic field is on, there is observed an electric vortex, or whirl of electric ions around the wire. Positively and negatively charged ions spin in opposite directions depending upon the strength of the magnetic field. Ehrenhaft suggests that the electric action of magnetic current represents the third force in Nature besides the force of gravity and the well-known force of magnetic action of electric current.

Unfortunately, the life of the magnetic current hypothesis has been very brief. The staggering implications of Dr Ehrenhaft's observations have led several renowned scientific firms to duplicate these experiments under rigidly-controlled conditions. Hitherto, the results have been uniformly negative.

Hopper[2] has attempted to verify the existence of magnetic ions, using a horizontal magnetic field, instead of vertical one as used by Ehrenhaft. Fine particles of nickel are drawn by an air current between the poles of the magnet and then allowed to settle under the combined action of vertical gravitational and horizontal magnetic fields, their path being observed by means of a microscope. In the centre of the magnetic field, all the particles fall vertically downwards, thus disobeying the "magnetic ion" hypothesis.

Goldman[3] of the Westinghouse Research Laboratory has repeated the magnetolysis experiment carefully. When the pole-pieces are covered with paraffin and boiled acidulated water is used, no gas bubbles are evolved. When the paraffin coating is removed, there is liberation of only hydrogen gas. In neither case there is a loss of pole-strength of the magnet, although they are exposed to "magnetolytic action" for about 60 hours.

Hoff, Naughton, Smoluchowski and Uhlig[4] of the General Electric Co. Research Laboratory have examined the gases evolved by the action of dilute sulphuric acid (prepared from boiled distilled water and cooled in a nitrogen atmosphere) and magnetized iron. They have failed to detect any oxygen within 0·2 per cent per volume of the total gas evolved.

Ehrenhaft's reply to the above refutations of his theory has not yet reached us. In any case, it must be admitted that his theory is remarkable for its striking originality and boldness of conception. Let us hope that it will at least serve to stir the imagination of the scientific world for exploring new pathways into the mysteries of magnetism which has undeniably received scant attention compared to its sister science of electricity.

Ehrenhaft was responsible in the past for stirring up two similar controversies which, without substantiating the deviations from the accepted views claimed to have been observed by him, have produced a large number of new and critical experiments which placed the accepted views on surer experimental foundations. These were: (*i*) the discovery of subelectrons, and (*ii*) observation of negative radiation pressure effect produced on certain kinds of microscopic particles.

References

1. Ehrenhaft, *Phys. Rev.*, *65*, 287, 1944; *Nature*, *154*, 426, 1944.
2. Hopper, *Phys. Rev.*, *66*, 93, 1944.
3. Goldman, *Phys. Rev.*, *66*, 94, 1944.
4. Hoff, Naughton, Smoluchowski and Uhlig, *Phys. Rev.*, *66*, 92, 1944.

THE ORIGIN OF THE SOLAR SYSTEM

A. C. BANERJI,
DEPARTMENT OF MATHEMATICS, ALLAHABAD UNIVERSITY

ON May 24, 1943, the world of science celebrated the fourth centenary of the passing away of Nicholas Copernicus, the Polish savant, who effected a revolution in man's ideas and processes of thinking, a revolution, the full effect of which has not yet been realized in any country except Soviet Russia. What was this revolution?

From time immemorial man had believed that the Earth was the centre of the world, the seat of the Creator, and he was the special object of favour of God and was born in his own image; that the Sun and the Moon were created to give him light, and the planets to the tune of the mysterious number seven, including the Sun and the Moon, by their mysterious motions, indicated the decree of the Creator regarding the fates of individuals, nations and countries. These ideas were further worked out into a system by the astronomer Ptolemy who flourished in Alexandria about 140 A.D.

In the Ptolemaic System the earth was regarded as stationary, and the Sun and the planets moved round the Earth. It was firmly believed that the Sun really rose each morning in the east, climbed overhead, and then set in the west.* On the other hand, Copernicus showed that the phenomena of planetary motion are explained far more easily if we regard the Sun as stationary and make the earth and the planets move round it in orbits, which he believed to be circular. Mercury and Venus revolved in orbits inside the earth's orbit, and the rest outside it. The mysterious retrograde motions of planets, which were the basis of astrological superstitions, then come out merely as the effect of relative positions and relative motions of the planets with respect to the moving earth.

Copernicus was the first to suggest that the Earth moved round the Sun completely in one year and rotated round its axis once a day. The daily rotation of the Earth explains quite simply the phenomena of rising and setting of the Sun.

Copernicus left the work unfinished, and it was left to Galileo, Kepler and Newton to complete it. Kepler showed from observational data that the planets move in elliptical orbits with the Sun at the focus, and Newton explained it mathematically with the help of his famous law of gravitation. The retrograde motions of planets could be explained as merely an effect of perspective due to changing positions of two moving bodies, and hence the bottom was taken out of the pretentious claims of astrologers.

Laplace's Theory

The above explanation of planetary motions by Newton brought to the forefront another set of questions. What is the origin of the Solar System? Does life exist in any other planets except the Earth?

An answer to the question of the origin of the Solar System was first attempted by Immanuel Kent, philosopher of Königsberg in Germany, and Marquis de Laplace, mathematician of the French Revolution. They thought that the solar universe started as a huge nebular mass, which contracting on account of gravitational attractions of its parts, developed rotation and began to throw out fragments in the form of rings. The fragments condensed as planets and satellites and the central mass condensed as the Sun.

Laplace's theory was able to explain many of the regular features of the Solar System, *viz.*:

(*a*) The planets are revolving in their orbits in the same direction and almost in the same plane.

(*b*) The satellites are revolving round the planets in the same sense as the planets moving round the Sun.

* This idea which Ptolemy inherited from antiquity, was questioned earlier by Aristarchus of Samos, who thought that the phenomenon of rising and setting could be much better explained by making the earth move like a top round its axis. But this hypothesis was not accepted by Ptolemy. Six hundred years later Aryabhata in India also gave the same explanation independently; but his followers, Brahmagupta and others ridiculed the idea.

(*c*) The rotations of the planets and their satellites about their respective axes are in the same direction as their revolutions in their orbits. The Sun is also rotating in the same sense.

(*d*) The eccentricities of these elliptic orbits are small, *i.e.*, the orbits are very nearly circular in shape.

One of the chief objections to Laplace's Theory was that if the fragments of the rotating nebula were given out in extended tenuous rings, the rings could not be condensed into single planets, but into many bodies like the asteroids or the rings of Saturn, which would be stable as proved mathematically by Maxwell in 1859.

The most fatal difficulty, however, which the theory had to meet is the distribution of the angular momentum between the planets and the Sun. The angular or rotational momentum may be roughly described as the "quantity of rotation" in any dynamical system, as Newton spoke of ordinary momentum as the "quantity of motion". Its importance lies in the fact that the whole momentum should be *conserved*. No internal forces in a system can alter its total amount, though they may transfer it from one part of the system to another.

It is found that almost all the angular momentum of the Solar System -98% of the total—is obtained from the orbital motion of the four major planets. The four minor planets provide less than 0·1% of the whole, and the rest is contributed by the Sun's rotation. It cannot be explained by Laplace's theory how 98 % of the total angular momentum can be seggregated into less than 1·5 % of the total mass. It can also be mathematically proved that if the outer parts of the primitive nebula had got so much of angular momentum, they could not have condensed at all. So it is natural to imagine that the angular momentum of the planets must have been obtained from outside. In the language of Spencer-Jones (1940) we may, therefore say that the origin of the Solar System "must be sought in the swift catastrophic action of forces from outside".

The Hypothesis of Dynamic Encounter

The catastrophic action was supposed to have been brought about by a very close passage of another star to the Sun. This assumption has been made in the Planetesimal Theory of Chamberlain (1901) and Moulton (1905), and in the Tidal Theory of Jeans (1919) and Jeffreys (1929). In both these theories, the Sun was once an isolated star without any planet. At a remote epoch, another isolated star moving through space happened to come very near the Sun. These two stars swung about one another and separated again. They came so near together that tide raising forces became great, and huge quantities of matter were ejected from the Sun.

According to the Planetesimal Theory, most of the ejected matter was in the form of small solid particles revolving round the Sun and the present planets have grown by gradual accretion of these small bodies. Chamberlain believed that the planets, except perhaps the largest, were solid throughout, practically from the beginning. In Jeffreys' opinion, the ejected material must originally have been gaseous and very hot. If ejection was continuous, the ejected matter would form a filament and lie within a long narrow range. Its shape will resemble that of a boomerang which is a hard wooden missile used by the primitive races of Australia. Due to radiation the filament began to cool ; condensation would begin when the length of the strip already ejected reached a certain value. The ejected portion would then get detached from the main body, and it would

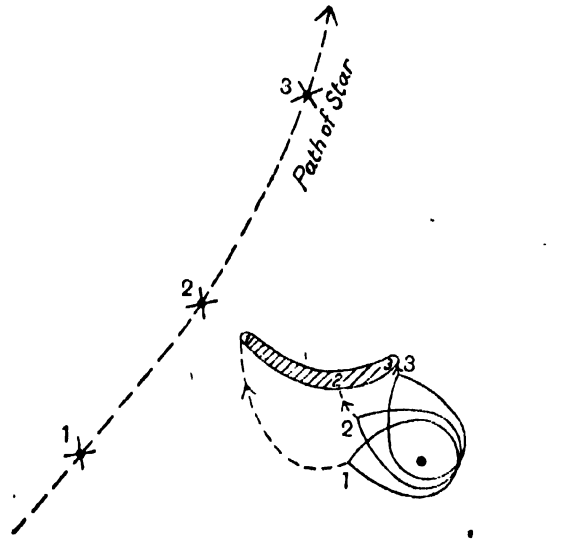


Fig. 1. Diagram of the changes in the form of the solar envelope and the paths of portions of the ejected matter during the passage of the star. ('The Earth' —H. Jeffreys).

then begin its independent existence as a planet. If ejection continued, a second planet would be formed, and others would successively be born until ejection ceased. As the disturbing stars receded, the early planets would retain their identity whereas those which were formed last would fall back into the Sun.

Russell has pointed out a great difficulty which arises in the Tidal Theory when we consider the distribution of angular momentum per unit mass of the passing star, the Sun, and the planets. In order to produce tidal eruptions, the star must have almost grazed the Sun. If it was of the Sun's size and mass, its nearest distance from the Sun could not have been much more than a million miles. Based on these figures if we take the angular momentum per unit mass of the earth to be unity, that of the star is found to be 0·25, and the average angular momentum per

unit mass for the planetary system is found to be 2·63. This is more than ten times as great as that for the star. So it is inconceivable how so much angular momentum can be put into the ejected material by the passing star. This is indeed a fatal objection to the Tidal Theory.

The "Enticement" Theory

On Russel's suggestion Lyttleton (1938) advanced the "Enticement" Theory of the Solar System. The Sun was pictured primarily as a binary star, and its companion had a tidal or "side sweeping" encounter with a third star, and ultimately escaped from the Sun. The visiting star had a large mass (much greater than the Sun) and velocity so as to provide enough energy for the shearing of the planetary material. The Sun was supposed to have been just so far off as to avoid capture by the visiting star, but nevertheless near enough to capture chunks of the planetary ribbon formed between the Sun's companion and the visiting star.

The validity of this assumption has been questioned by Luyten (1939) who showed that if the Sun comes near enough to capture chunks of this planetary material, it will itself be captured by the more massive visiting star.

Bhatnagar (1940) has shown that even under most favourable conditions there would be a catastrophic collision between the three bodies, if they come near enough for a planetary ribbon to be formed.

From astrophysical considerations, Spitzer (1939) has drawn the conclusion that the planetary ribbon, if formed, would dissipate into space in an hour at the most at stellar temperature. Lytttleton (1941) has, however, pointed out that Spitzer has neglected an important factor, *viz.*, the gravitational field of the stars concerned. By taking the attraction of the stars into account, it can be shown that the temperature required to give escape velocities to the particles in the filament would be greatly in excess of the usual stellar temperatures.

Other Theories

It has also been suggested that our Solar System originated from a heterogeneous nebula of irregular shape. In this case we can suitably select our initial motion and configuration to get our final arrangements of the planets and the satellites in the solar system. The possibilities of such a hypothesis are rather too many and it would be begging the question if we make any assumptions, without giving reasons for them, as any assigned final arrangement can be obtained by making suitable premises about initial motions and configurations.

Nölke (Russell, 1935a) suggested in 1930 that the Sun and the planets were formed almost at the same time from a wisp of a filamentary nebula which had one large condensation and a large number of smaller knots. There is no doubt that certain diffuse nebulae have got wisps or filaments, but their composition is not known. Nor can it be said whether such filament is twisted or lies in one plane, or whether the motion of its parts are coplaner or not. It would not be justifiable to make *ad hoc* assumptions for reasons given in the last paragraph.

Ross Gunn (1941) supposes the planetary system to have been formed out of a rapidly rotating star which would break up by fission preferentially in the vicinity of another star. The difficulty with this theory is that such close encounters in which one of the approaching stars is rapidly rotating with angular velocity almost equal to its critical value for fission are highly improbable.

Recently, Lyttleton (1941) has also considered the question of planetary formation resulting from the break-up of a single stellar mass from rotational instability. He regards the Sun as the distant companion of a close double star whose components had at first merged into a single body, and later on, this mass broke up into a pair of stars due to rotational instability, and a planetary filament was produced between them as they were separating from each other. Lyttleton supposed that the process of coalescence was brought about by accretion of inter-stellar matter. It may be mentioned here that Atkinson (1940) had earlier questioned the possibility of such a coalescence.

The Frequency of Planetary Systems

It is worthy of remark that all these theories have one feature in common, *i.e.*, the birth of the planetary systems must be an exceedingly rare event. Moreover, as Spencer-Jones (1940) has said, in these theories "so many special assumptions are involved that the Solar System had a very narrow escape from never coming into existence." According to his older theory, Jeans (1929) estimated that in the whole of the galactic system, planetary systems come into being at the rate of about one in five thousand million years.

Two different time-scales have been proposed for the age of the Universe. Those who believe in the long-time scale maintain that the evidence provided by the physical conditions and the distribution of stars in the galaxy suggest an age of at least 10^{12} years for these bodies. We may call them "trillionaires". Others believing in a short-time scale argue from the theory of relativity that the age of the Universe must be between 10^{9} and 10^{10} years. They may be called "billionaires". Whittakar (1942, Beginning and End

of the World, Riddel Memorial Lectures) has recently suggested an intermediate time-scale, *viz.*, 5.10^{10} years for the age of the Universe.

As a rough estimate we may say that the chance of forming a planetary system for a given star of ordinary size is one in 5.10^{17}. If we allot an average age of 5.10^{12} years to stars on the "trillionaire" scale, we find that only one star in 100,000 can have found a planetary system in the whole of its life, so that only about one star in 100,000 is at present surrounded by planets. If we take an average age of 5.10^{9} years, on the other hand on the "billionaire" scale, we see that only one star in a hundred million can have a planetary system in the whole of its life, so that only one star in a hundred million is at present surrounded by planets. On the Tidal Theory, planetary systems are, therefore, "freak formations" of nature.

It is believed that our galactic system, which comprises the whole of the Milky Way, is a spiral nebula, rather bigger than the Andromeda Nebula. If viewed from outside, the coils of the Milky Way will give the same spiral appearance to our system as the coils of Andromeda Nebula. It is also believed that our galactic system contains stars of the order of one hundred thousand millions in number.

With Jeans (1929) we may regard that roughly the stars of the galactic system consist of about a hundred million packed as closely as the stars in the neighbourhood of the Sun, and a far greater number scattered far more sparsely in space. In the former group of the hundred million stars, under the long-time scale for the age of the Universe, there can be about a thousand stars surrounded by planets, and on the short-time scale, there can be only a single star surrounded by planets. In the latter group of stars of the galactic system, the stars are so sparse that the chance of planetary systems coming into being may be almost neglected.

It need be hardly mentioned that the encounter between two stars is much less probable on Lyttleton's "Enticement" Theory (1938), and the chance for the birth of a planetary system is practically nil.

Jeans' New Theory

Recently *Jeans* (*Nature*, June 20, 1942) completely changed his faith. He now believes that a far larger proportion of stars than what was imagined before must be accompanied by planets. Life may be incomparably more abundant in the Universe than what was thought before. Out of the vast total number of stars, there must be millions which are almost exact replicas of our Solar System, and that millions of their planets must be almost exact replicas of our earth. According to Jeans, there must have been a time in the remote past, when the Sun, then rapidly contracting, extended to thousands of times its present radius. It was still a semi-nebulous mass. If the original radius of the Sun was n times its present radius, then the chance of planets being generated by a tidal encounter of the type contemplated by Jeans' new theory would be n^2 times as great as that given by his older theory. According to the new theory of the various planetary systems of the sky, the vast majority were formed when their Suns were still in the semi-nebulous state.

If the original Sun extended up to the orbit of Uranus, a little calculation will show that the chances of planetary formation would be seventeen million times as great as now. Then, according to our former calculations, in the long-time scale, all the stars of the galactic system would have planets 170 times over, and each star must have experienced encounters at least 170 times since its birth. This is inconceivable. On the short-time scale, one out of every six stars should have a planetary system. This, too seems to be over-generous.

The Cepheid Theory of the Origin of the Solar System

It has also been suggested that the raw material which ultimately formed planets was shot out of the Sun by powerful internal forces. If there were sufficient initial impulse, the planets could easily have been formed at their present distances, while the attraction of a passing star would set them revolving in their present orbits. In a recent paper, the writer (1942) has shown how a state of dynamical instability can be brought about in a star which would result in the ejection of matter to planetary distances and in the formation of planets.

The Sun is supposed to have been originally part of a Cepheid Variable of about nine times its mass, oscillating with small amplitude. The Cepheid Variables form a class of stars which vary periodically in brightness owing to an actual pulsation, periodic change in the size of the star, the period being anything from a few hours to a few weeks. Delta-Cephei (δ-Cephei) star is a typical star of this class with a period of a little over five days.

The near-by passage of a star of about the mass of this Cepheid increases the amplitude of the Cepheid oscillation. The passage of this second star need not be grazing or very near, but only sufficiently near to produce appreciable tidal protuberances in the original Cepheid. So long as the amplitude remains small the pulsation of the Cepheid is stable, but if the amplitude increases, due to the tidal protuberances, the pulsation remains no longer stable, and matter comparable to the Sun's mass may be ejected from the parent Cepheid, as the writer has shown. It has also been shown that the visiting star can have sufficient

angular momentum to impart the necessary amount to the planets. It has been calculated that the Solar System will have to take about two-fifths of the energy of the parent Cepheid to escape from the latter. The parent Cepheid will also get a planetary system of its own. As the visiting star need only pass at a moderate distance from the Cepheid, the birth of a planetary system is much more probable on the writer's theory. In fact, his theory has been wound up with the following remarks, "one conclusion seems to be irresistible, if the theory be correct in its essentials, there may be more planetary systems than at present supposed."

Electromagnetic and Nuclear Theories

Alfven (1943) has recently suggested that the planets were formed out of interstellar matter which had probably originated from a gas cloud once surrounding the Sun and fallen towards it through its attraction. As soon as this matter became ionized by heating due to gravitation, it was stopped by the action of the Sun's magnetic field. The main portion of the matter accumulated at a distance r from the Sun when the gravitational energy balanced the ionization energy. It is found by calculation that this distance is approximately equal to the mean distance of Jupiter from the Sun. It is also claimed that this theory accounts satisfactorily for the distribution of angular momentum among the various planets of the Solar System.

Fesenkov (1944) has suggested that at different intervals in the life history of the Sun various energy-producing nuclear reactions occurred at critical periods and caused *sudden* contraction of the Sun resulting in the ejection of material from which planets were formed.

Discovery of New Planetary Systems

Theory has thus given us conflicting verdicts on the question, "Are there other planetary systems than our own?" Observation had not so far disclosed any. In fact, Russell (1935) said that even if there be any planetary system in some of the distant stars, they would not be visible even through most powerful telescope we can construct. Proxima Centauri, the star nearest to the Solar System, is at a distance of 4·3 light years, *i.e.*, about 24 trillion miles from us. The light year is the distance which light travels in one year at the speed of 186,285 miles per second. It is equivalent to $5{\cdot}88 \times 10^{12}$ miles or 5·88 trillion miles. Kothari has shown that Jupiter probably represents geometrically the largest piece of cooled matter that can in principle exist in the Universe. So no star can have a planet bigger (geometrically) in size than Jupiter. But there is nothing to prevent a planet from having a mass greater than that of Jupiter. Proxima Centauri has a mass approximately equal to one-seventh of Sun's mass. It is a faint star whose intrinsic brightness is much less than that of our Sun. It has a visual magnitude 10·5. The apparent brightness of a star is described by the term "visual magnitude". A star having a lower "magnitude" is brighter than one having a higher "magnitude". A star of the first magnitude is 2·512 times as bright as a star of the second magnitude. Stars and heavenly bodies very much brighter than stars and of the first magnitude will have negative magnitude. For example, it may be mentioned that the visual magnitude of Sirius (Dog-star) is -1·6 ; of Venus, about -4 ; of the Full Moon, -12·5 ; and of the Sun -26·7. A standard candle at a distance of one metre is of magnitude -14·2. Faint stars up to 21st magnitude and not more can be photographed with the hundred-inch telescope at Mt. Wilson. The visual magnitude of Jupiter as it appears to us is -2·2. If Proxima Centauri has a planet equal to Jupiter in size and brightness as it appears to us, a little calculation will show that it will have a visual magnitude 22. So such a planet cannot be photographed by the Mt. Wilson telescope. Nor can it be seen through such a telescope which can barely show stars of the nineteenth magnitude. Even if there be a brighter planet whose visual magnitude is less by two or three integers it cannot be detected either visually or photographically through the most powerful telescope in use now through the close proximity of the parent star which is relatively a much brighter body.

It is, therefore, both romantic and most welcome that news has come from America of the discovery of two planetary systems outside our own Solar System. From the study of parallax observations, Dr K. Aa. Strand (February, 1943) has detected the presence of a planetary body in the 61 Cygni system. 61 Cygni is a well known double star of the fifth magnitude in the constellation of Cygnus. This star is historically important as in 1838 Bessel made the first reliable measure of its parallax and obtained its distance from the Sun. Its distance from the Sun is 10·9 light-years.

Generally the two members of a double or binary star are of unequal brightness. The brighter star is called the primary and the fainter is called the companion. The orbit of a binary star is defined to be the elliptic orbit which the companion will describe relative to the primary. In 61 Cygni system, the primary star has the visual magnitude 5·57 and the companion has the visual magnitude 6·28. Both the star and its companion have mass about half of that of the Sun. The period of this binary star is 720 years and the length of the semi-major axis is 84 astronomical units, an astronomical unit being the

semi-axis major of the earth's orbit or $9{\cdot}29 \times 10^7$ miles approximately.

Measurements were made by Dr Strand on a large number of photographic plates of 61 Cygni taken over a dozen years. The measures on the newer plates, if reduced on the assumption that the system consists of only two components, and statistical calculations based on them reveal certain features which show that the orbit of the visual pair has deviations from Keplerian motion which can only be explained by assuming that a third invisible body of small mass, which may be designated as 61 Cygni C, revolves round one of the two main components. It is not yet known to which of these components this small body 61 Cygni C, or the planet is attached. As both the main components have closely similar masses, so whichever is used as the primary star or the Sun for the planet in computing the elements of its small orbit, the same result will be obtained. It is found that this planetary body has a remarkably small mass, only one-sixtieth that of the Sun, or approximately sixteen times that of Jupiter. It has mass about one-tenth that of the lightest known star, Krüger 60 B. It has also a very low luminosity. It revolves in a highly eccentric orbit ($e=0{\cdot}7$) of semi-axis major 2·4 astronomical units. This is the first time that a planetary body belonging to a system other than our own Solar System has been detected.

In January 1943, Reuyl and Holmeberg announced the discovery of an even smaller planetary body in the system 70 Opiuchi which is also a binary star in the constellation Opiuchus at a distance of about 17 light years from the Sun. The semi-axis major is about 23·5 astronomical units with a period of about 18 years. Measurements were made on a large number of plates. It was observed that deviations from the binary orbits were markedly periodic both in right ascension and declination ; a period of about 17 years was deduced, amplitudes being 0·014. The visual magnitudes of the two main components are 4·3 and 6·0 and their masses are also different. It has not yet been found out to which of the two components the planet is attached. If it be attached to the primary having a mass 1·1 times that of Sun, its orbital radius would be 6·8 astronomical units, and its mass will be 12 times that of Jupiter. If the planet be attached to the companion having a mass 0·7 times that of the Sun, its orbital radius will be 5·9 astronomical units and its mass will be 8 times that of Jupiter. In 70 Opiuchi, the size of the binary orbit is about 3·5 times that of the planetary orbit. So the stability of this planetary orbit in the above star seems to be a little doubtful.

It may be mentioned here that a theory of the origin of the binary stars has recently been advanced by H. K. Sen (1941-2) on the lines of the writer's Cepheid Theory (1942) of the origin of the Solar System. A Cepheid which had originally a uniform density is supposed to have broken up into a double star system on account of increase of angular velocity brought about by contraction due to radiation of energy. The recent observational fact of two binary stars being endowed with planets seems to corroborate the Cepheid Theory of the origin of the binary stars. It may not be out of place to mention here that Cepheids are found in both the Constellations of Cygnus and Opiuchus.

Life in other World

To the other question set at the outset—about life in other worlds, we can scarcely say a conclusive word. Life, as we understand it, can exist only in those parts of the Universe where existence of matter in all the three states *viz.*, solid, liquid, and gaseous, is possible ; and the temperatures and physical conditions are very similar to those observed on the surface of our Earth. Let us first examine the possibility of existence of life in the planets of our Solar System.

Of the inner planets, Venus appears to be the best suited to be the abode of life such as exists on the Earth ; yet for some reason life has never developed there. The absence of oxygen in the atmosphere of the planet is perhaps mainly responsible for non-existence of life there. On the dark side, Venus may have a temperature of about -23°C, and on the bright side 57°C. These temperatures are not unsuitable, however, for the existence of some kind of life.

Among the outer planets, Mars is the only one where it may be possible for some form of life to exist. Jupiter has a mean surface temperature of -138°C, and it is too cold for any sort of life to exist there. Saturn and the other planets are still colder.

Mars is colder than the Earth, but the warmest portions during summer in Mars may have a temperature as high as 25°C at mid-day, but the temperature is likely to fall so low that everything must freeze up hard every night. These conditions, therefore, would be very unfavourable to most of the forms of life that have developed in the more genial climate of the Earth. But it is very probable that some sort of vegetable life similar to that of our Earth might exist in Mars. That animal life may exist in Mars is not wholly impossible as some low forms of life can endure the Martian temperature and physical conditions.

There is no doubt that Mars has got an atmosphere. Recent observations show that there are only traces of oxygen in the Martian atmosphere. Clouds and fogs, though comparatively rare on Mars, have been observed many times in its atmosphere. Many of the surface markings of Mars show seasonal changes. Polar caps or the brilliant white patches

over the poles of Mars shrink considerably in Martian summer and become extended in winter. It is quite possible that these caps are composed of snow or frozen water ; much of it melt in summer. The temperature of the polar cap in winter may become as low as -70°C. Dark regions are also observed on the surface, which undergo seasonal changes in shade and depth of colour from greenish to yellow. It is quite possible that these regions indicate vegetation. A large number of more or less linear markings are also observed on the planet's surface. The American astronomer Percival Lowell and the Italian astronomer Schiaparelli thought that these markings are straight, narrow, uniform in width, and connected with one another in definitely geometrical arrangement. They called these the "canals" and suggested that these canals must be the products of intelligent design whose execution required engineering skill of a high order. There are also many small dark regions at the intersections of these canals.

There is progressive darkening of the canals and oases, in summer, after the melting of the polar caps. Lowell, therefore, thought that they were irrigating channels along which water was conducted in all directions from the poles to the equator and beyond in summer. This water must have been propelled artificially, and intelligent beings who constructed the canals were still operating it. Other astronomers like Barnard and Antoniadi believe that these so called canals are not canals, but they comprise a number of irregular patches. The appearance of linear markings arises from the integration, by the eye, of details too delicate to be seen well singly.

The absence of oxygen in the Martian atmosphere beyond traces conclusively shows that higher forms of life are at present non-existent in Mars. In some remote past, when the amount of oxygen in the atmosphere was adequate to maintain life, intelligent beings with highly developed civilization might have existed there.

In accordance with recent theories, there may be many more planetary systems in the Universe and there may be many planets which are almost exact replicas of our earth. Life might have developed on these, as it has done here, and it might have followed the same path as our terrestrial life. Life in some of these planets may be much more highly developed than ours, and who knows that even four hundred years after Copernicus "we may be the most ignorant cosmogonist in the whole of space."

References

Alfven, *Nature*, Dec. 18, 1943.
Atkinson, *M. N.*, *100*, 500, 1940.
Banerji, A. C., *Proc. Nat. Inst. Sci. India*, *2*, 173-197, 1942.
——————— *loc. cit.*, p. 196, 1942a.
Bhatnagar, P. L., *Ind. J. Phys.*, *14*, 253, 1940.
Chamberlin, *Ap. J.*, *14*, 17, 1901.
Fesenkov, *Observatory*, June, 1944.
Gamow, G., "The Birth and Death of the Sun," p. 168, 1940.
Gunn, R., *Phys. Rev.*, *59*, 690, 1941.
Jeans, J. H., "Problems of Cosmogony and Stellar Dynamics", p. 1, 1919.
——————— *loc. cit.*, p. 275, 1919a.
——————— "Astronomy and Cosmogony", p. 409, 1929.
——————— *loc. cit.*, pp. 7, 22, 1929a.
Jeffreys, H., "The Earth", p. 16, 1929.
Jones, H. S., "Life on Other Worlds", p. 219, 1940
——————— *loc. cit.*, p. 234, 1940a.
Luyten, *M. N.*, *99*, 692, 1939.
Lyttleton, R. A., *M. N. 98*, 536, 1938.
——————— *M. N.*, *101*, 216, 1941.
Moulton, *Ap. J.*, *22*, 165, 1905.
Reuyl and Holmeberg, *Ap. J. 97*, 41, 1943
Russel, H. N., "The Solar System and its Origin", p. 113, 1935.
——————— *loc. cit.*, p. 124, 1935a.
Sen, H. K., SCIENCE AND CULTURE, 7, 582, 1941-42.
Spitzer, L., *Ap. J.*, *90*, 675, 1939.
Strand, K. A., *Publ. Astron. Soc. Pac.*, *55*, 29, 1943.

DR. BURNS ON AGRICULTURAL DEVELOPMENT IN INDIA

IN pursuance to the agreement arrived at by the Committee of Agriculture, Forestry and Fisheries of the reconstruction committee of Council, this comprehensive memorandum "on the technological possibilities of agricultural development in India" is prepared by Dr W. Burns, D.Sc., Officer on Special Duty, Department of Education, Health and Lands, Government of India. This document forms the basis of an "All-India Policy of Post-war Agriculture" and forms the raw materials for discussion by the reconstruction Committee.

The subject-matter dealt with is divided into two sections: (1) crops and (2) livestock. So far as the crops are concerned the report has taken into consideration both (*a*) the food crops and (*b*) cash crops. The past and present crop production data of the principal crops mainly in British India over the last three decades is fully illustrated by means of tables and graphs. These graphs deal with (*a*) acreage and production of principal crops in India, (*b*) total area and total production of major food grains and population of India, (3) acreage and production of particular crops in the provinces, where they are most important, and (4) production of major food grains for each province with the population of the province. The graphs and tables are important not only as showing actual production, seasonal effects and trends but also as data for the

discussion following. In every case years of maximum and minimum production and acreage with the causes of any violent fluctuations are indicated. Fluctuations are most marked on crops which depend on rainfall. The cash crops are affected by the prices prevailing in the previous year.

In India, as a whole, population is increasing more rapidly than the production of food crops. This tendency is most marked in Madras and least so in the C. P. Many Indian States do not prepare agricultural statistics at all, excepting a few that represent only 56 per cent. of the area and 67 per cent. of the population of all the Indian States.

Dr Burns has tried to assess the technological possibilities of increasing the crop yields per acre which research has shown to be possible (1) by using improved varieties of seed, (2) by application of manure and, (3) by protection from pests and diseases. He has actually estimated the extent to which the present average yeild per acre could be raised if all these known methods of improvement are put into effect.

Thus in the case of rice, the average outturn of rice per acre during the last five years was 738 lbs. At a conservative estimate, this yield can be increased by 30 per cent, *viz.*, 5 per cent by using improved varieties, 20 per cent by increasing manure and 5 per cent through protection against pests and diseases, or even up to 50 per cent, *viz.*, 10 per cent by variety and 40 per cent by manuring. This would raise the production of rice to 959 lbs. per acre and Dr Burns suggests that India should aim at an average of 1000 lbs. of rice per acre—an average already achieved in some provinces of India.

It is significant that in one province of India, *e.g.*, Coorg, the ordinary cultivator manages to produce about 1,254 lbs. of rice per acre and a certain well-managed Indian State in Coorg produces 2,608 lbs. per acre. In addition to suitable soil and climate, the main factors for this high yield are (1) use of a high yielding variety and (2) manure and water.

Similar estimates of increased yield of other principal crops, *viz.*, wheat, jowar, bajra, maize, gram, pulses, linseed, brassica oil seeds, ground nuts, castor, sugarcane, cotton, jute and tobacco are given. No statistics of acreage and yield for fruits, vegetables and potatoes are as yet available. Given disease-free seed-potatoes and suitable manuring, the production of potatoes on the existing acreage can be doubled.

In 1941, the I. C. A. R. attempted to introduce improved seeds of rice and better cultural practices, so as to increase the outturn per acre and gradually increase the acreage by bringing more land under cultivation in Madras, Bengal, U. P., C. P., and Orissa. But this scheme has been somewhat overshadowed by the "Grow more food" drive, which aims at increasing acreage and yield of any variety whatsoever.

The effect of the "Grow more food" campaign of 1942-43 is summarized. Of the main food grains, *viz.*, rice, wheat, millet and maize, the acreage was increased over previous year by 8,400,400 acres and the production by 3,856,000 tons. In addition to increase in area of cultivated lands, a large portion of land under cotton cultivation was diverted to food production.

Propaganda, financial assistance by the Government, a favourable monsoon and conditions favourable for sowing and maturing are the factors responsible for this large increase in the area under food grains, and Dr Burns suggests that a combination of persuasion, concessions, and compulsion is best calculated to bring more lands under cultivation.

Live Stock

An estimate is made of milk production by cattle, buffaloes and goats, production of eggs by poultry and the annual production of cattle manure. As in the case of food crops, the technological possibilities of increasing milk production, which scientific method has shown to be possible, are indicated. Milk production can be increased by 75% *viz.*, (*a*) 30% by feeding, (*b*) 15% by breeding, (*c*) 15% by management, and (*d*) 15% by control of diseases.

Making full allowances for the fodder available at present, there is a deficiency in both (*a*) *concentrates* consisting of oil cakes, seeds, brans and pollard and (*b*) *roughages* consisting of special food crops like jowar, natural grasses available and straws of food crops. Available supply of concentrates and roughages are sufficient for only 29·14 per cent and 78·53 per cent, respectively of the existing cattle population.

There are 85,000 sq. miles of forest grazing in India, but this is accessible to only a small percentage of animals. This source should be developed and reserves of fodder built up against famines.

The Shape of Things to Come

In agricultural development, two objects must be clearly held in view *e.g.*, (1) abolition of the poverty of the cultivator and (2) abolition of the poverty of the soil.

To achieve these objectives it is necessary to save all wastage of fertilizing material, water, soil, etc. and utilizing these to the maximum capacity. It is further necessary to strengthen the provincial and State departments of agriculture and a collective action in such matters as soil conservation, control of pests and diseases and wild animals.

Dealing with manures, Dr Burns observes that Indian soils have become stabilized at a comparatively low level of production. It is not difficult to ensure increased yield specially by manuring with nitrogen from its various sources, *viz.*, (1) farmyard manure, (2) compost made of vegetable matter, with a small amount of cowdung, (3) urine earth from cattle byres, (4) compost made from town refuse, utilising town night soil, (5) green manuring, (6) oil cakes, (7) bones, (8) molasses, (9) other types of industrial waste such as cotton mill waste and (10) artificial manures, specially sulphate of ammonia. An estimate is made of the different kinds of manures available, many of which, *e.g.*, compost, is very inadequately utilised. "If the Chinese cultivator can apply to the land every scrap of available fertilizing material, so can the Indian cultivator. It is only a matter of discovering the best way to do it."

A rough calculation is also made for the quantity of manure which would be required for each of the main crops requiring such manurial treatment as is advocated by Dr Burns himself. So far as nitrogen is concerned, the total required for the principal food and cash crops, is estimated to be about 2·6 million tons every year and this could be had from 13·2 million tons of sulphate of ammonia (N = 20%) or 526 million tons of farmyard manure (N = 0·5%). He has however not stated the requirements for phosphates or other major plant nutrients.

India is maintaining about 200 million heads of cattle, which can be expected to produce 500-600 million tons of farmyard manure—which amount is quite sufficient to meet the manurial requirements of all our crops. The present position, is however, not so satisfactory, since more than half of the dung is being used as fuel, in farms, villages and towns. The present annual production of farmyard manure in British India is estimated to be about 250-300 million tons, and is enough to supply 1·0 ton of this manure per acre of cultivated land. We are at present deficient by about 250-300 million tons of this manure.

The answer to the ravages of insects, pests and diseases is the production of resistant varieties of crops where possible, but so long as that ideal method is not achieved, the use of more insecticides and fungicides is advocated.

The memorandum is concluded with some remarks on mechanization. For certain special operations, *e.g.*, original clearing of land under jungle, the eradication of deep rooted weeds, anti-erosion work and for cultivation on large estates, the use of power machinery in India is economical, but bullock-drawn implements must continue to constitute the main weapon of cultivation in this country.

A. K. G.

THE PROBLEM OF REHABILITATION

K. P. CHATTOPADHYAY,

ANTHROPOLOGY DEPARTMENT, CALCUTTA UNIVERSITY

A survey was carried out by the Anthropology Department of the Calcutta University during 1942-43, regarding the effects of the famine and the lines on which rehabilitation work should proceed. It was pointed out in a statement issued on the basis of the data collected that in many of the affected areas about thirty per cent of the small peasants had lost their land and that the proportion of fishermen who had lost boats, nets or fishery rights came to about twenty per cent. The estimates were prepared on the basis of a limited survey and are therefore subject to some revision. But they indicated the lines on which rehabilitation work should proceed, even though more exact figures available from an extended sample survey might modify the percentage. The complete results of the survey on a wider scale now in progress are not yet available for publication. But the earlier data, and what has been available since then regarding the economic condition in the affected areas permits us to indicate certain requisites for rehabilitation which have to be mentioned now in view of decisions already taken in this regard. Apart from short term relief, the principal requisite for the peasant who has lost part or whole of his small holding, is the restoration of his land. By an ordinance, now regularised by legislative measures, the Government have authorised restoration of land, distributing repayment of it in ten annual instalments. In the original note issued by the Anthropology Department it was pointed out that an ordinance or a law simply permitting restoration of land is inadequate. A peasant sells his land by which he lives, only when he has used up all his reserves—the few silver ornaments his womenfolk may have, the brass or porcelain pots and pans, and even his livestock. It is not possible for such a person who has thus

thrown himself on the labour market, as an unskilled labourer, to save up enough funds to deposit a sufficient amount to repurchase the land. According to the enquiries conducted by Kanungoes for the Floud Commission, nearly three fifths of the cultivators are small peasants with holdings of less than three acres, and the large majority of them do not possess even two acres of land. As a family cannot live on the land unless the farm is at least five acres in area, most of these families have to try to supplement their earnings by agricultural labour and subsidiary occupations. Estimates of income by the Bengal Banking Enquiry Committee as well as by Honourable Sir Azizul Huq (man behind the plough) indicate that these agriculturists cannot live by what they earn. The intensive work in the villages of Bogra (unpublished) by Mr Ramkrishna Mukherjee as a research scholar of the Anthropology Department, and his later work in Noakhali in connection with my limited survey (published in *Science and Culture*) support these conclusions and clearly bring out the chronic poverty and progressive deterioration of the condition of the peasantry even in what are held to be normal times. The poorer peasants have been steadily losing land in favour of the non-cultivating owner and this tendency has been accelerated, by the inflation and famine. In such circumstances, a permissive measure, without State help will be of very little use. The upper limit of the value of the land - Rs. 250/- is also too low. It will exclude from even the little benefit the special legislation can confer, the peasant who has parted with more than half an acre of land. The only real help that can be offered and be of use, will be available if the State comes forward to help with interest free loans on a long term basis, as a relief measure. Otherwise even the beginnings of rehabilitation cannot be made. It should be clear, that such relief should be for the poorer peasants, in the main. Our enquiries among the peasantry suggest that the Government loan has formed less than one tenth of the total borrowings for food, and even the little help given has not been in favour of the most needy.

From the point of view of permanent restoration of villages to an economic level in which they can live, much more has to be done besides restoration of land. Seeds, cattle and manure are now beyond the means of most small peasants ; later on they may be able to pay for these or obtain plough cattle by hire. But owing to their marginal position on the borderland of want, they have to pay more for all their requirements, and get very hard terms when credit is needed. The only remedy for this is to encourage the formation of co-operatives for production as well as for purchase of necessities. Another important need is protection from superior landlords. At present, if the landlord gets *khas* possession of any land, he is at liberty to settle it on any one. Often the choice goes to non-cultivating owners who are better off. The result is that the genuine cultivator can get land only as a *bargadar,* with half share of crops. Lack of protection in this respect can render inoperative beneficial land laws. Thus the land laws in the Punjab have to a great extent been rendered abortive owing to the failure to discriminate between cultivators and non-cultivating owners who employ labour to till their land or use the *bargah* (crop sharing) system. Even where the land has been actually reclaimed by the peasants, from the waste by co-operative drainage or embankment, with help from other sources (such as relief organisations) the local zamindar has been found to settle the land with other persons. In the old Hindu period the man who reclaimed the land had the first right to it, and the State or landlord received the rent only for protection and care of the peasant. Neither of them had the right of absolute disposal of such reclaimed land. Only if the fields were left fallow *i.e.*, practically not used could any interference take place. In the period of Muhammadan rule, these principles were not violated. They have continued to operate under British rule among our tribal people like Khasis and Mundas, and have been enforced by special legislation by the Government of India in the excluded areas like Santal Parganas or Kolhan. Our ordinary peasantry of the so-called advanced social groups are equally in need of similar protection. Land revenue officials who have administered partially excluded areas are well aware of this necessity. In an official report (which is now forty years old) on the need of protection of tribal people, it was stated very frankly by a British Director of Land Records that the great majority of Indian cultivators required to be protected, just like tribal people, in the matter of land tenure and transfer. In the Punjab, some protection has been given by the Land Alienation Act which prevents the transfer of land from the possession of one agricultural group to another or to outsiders. The consequent lack of credit is however a disadvantage to the small peasant who cannot earn enough to lay by for emergencies. The only remedy for this lies in the formation of co-operatives of cultivators with guarantee of a certain amount of Government loans at a low rate of interest. Otherwise, the peasant will have to go to a money-lender and suffer the evils consequent upon it. Legislation preventing transfers to non-agriculturists will merely lead to the growth of a class of money-lenders drawn from the richer peasantry. This has actually happened in the Punjab and it has been stated that this defect in Land Alienation laws in that province "has created a class of agricultural moneylenders who are even more rapacious than the non-agricultural moneylenders and that it has allowed the big land-

holders to buy up the small holders, who are the very men that stand in most need of protection".

Even in the so-called protected areas, considerations of revenue override that of welfare. In the Damin-i-Koh the Santal cultivator holds his raiyati land so long as he pays the rent and keeps the holding in a proper state of cultivation. No eviction can however occur without the sanction of the Deputy Commissioner. When a raiyati holding falls vacant for any reason, it has to be settled as follows, preference being given in the order mentioned.

(*a*) with a resident jamabandi raiyat of the same community ;

(*b*) with the headman if no resident jamabandi raiyat is available ;

(*c*) with a non-resident jamabandi raiyat only if no one of categories (*a*) and (*b*) are available.

While the solidarity of the village community and some protection of the rights of the tenant are thus ensured, certain other difficulties remain. It so happens that in the Santal and other Reservations, sufficient uncleared forest land is still available for cultivation. Hence an industrious peasant can make a living. Arrears of rent should not therefore normally occur. But in the developed areas, and among non-tribal peasantry, there is no such margin of land. Until long term rehabilitation can be effective, there must be provision for periodic help to the poorer peasantry. To evict such a peasant for failure of rent in a bad year is to turn him out to beg or to die.

The problem of the poor peasant can be temporarily and partially solved if the land laws are basically amended and certain other provisions made. It should be made compulsory to settle all vacant holdings with a resident cultivator of the same village, and not with non-resident cultivators or non-cultivating owners. If there is any co-operative of cultivators, it should receive preference. As landless agricultural labourers like to settle down as cultivators, there will be no dearth of suitable tenants. Regarding arrears in bad years, there should be a system of insurance against eviction. The incidence of the land rent on the actual cultivator is already high enough and should not be enhanced any further. But the unearned increment which goes now to the Zemindar and jotedar owing to the Permanent Settlement, as the result of clearing of uncultivated waste, and higher prices of crops, can certainly be tapped for this purpose. The State now gets about three crores of rupees as revenue and cess from land, and the landlords about seven crores and a half, after deducting expenses of management. Of this amount, at least two crores may be considered to be a fair estimate of the unearned income, which would have been available to the State if permanent settlement had not been adopted. An insurance fund may be created by imposing a cess on the Zemindari revenue, so long as the present system is in force. A portion of the ordinary Government revenue being the realisation of the State's share from the cultivator, should also be contributed for this purpose. The actual incidence of rent in different parts of Bengal should be mentioned in this connection. The incidence of rent in the less fertile tracts of Western and Central Bengal is much higher than in the more productive areas in Eastern Bengal. Often they are three times as high as the rent in the more favoured areas. A revision of the rent on rational lines on a uniform basis will not it is believed, affect the revenue of the State.

All these are however temporary devices. Permanent improvement can come only if (*a*) the land is made more productive and (*b*) the pressure of population on land is less. Co-operative agriculture, with manuring, and irrigation can increase the yield by at least fifty per cent. But large tracts in Western and Central Bengal cannot be irrigated unless the State takes up a planned project. More than twenty years ago, engineers of the Government Irrigation Department recommended the building of huge irrigation reservoirs to store the vast volume of water that drain into the Damodar and Barakar, during the rainy season, from the Chota Nagpore division and flood Western Bengal. Such a project can save Western Bengal from inundation and also provide irrigation facilities during the dry months to a large tract of otherwise fertile land, where no second crop can now be grown. There is some talk of constructing dams for irrigation and power now in connection with the plan for building up of an industrial belt in Chota Nagpore on the lines of the Tenessee Valley scheme. Every attempt should be made to expedite the irrigation project for Western Bengal in this connection.

The second desideratum, of reduction of pressure of population on land can be attained only if other sources of income are opened up for those who have had to fall back on land or work on land owing to failure to make a living in their traditional occupation. Artisan castes and artisan families like potters, oil-pressers, and weavers have been thrown on the land steadily during the past hundred years owing to competition with machine made products and substitutes. Only a small proportion of these people have been absorbed in industry.

The remedy is obvious—industrialisation. Some hardship is of course inevitable during transition from a culture based on individual production of

handmade goods to an industrial regime. It will however be much less than the chronic long drawn out agony of universal poverty due to lack of modern development. In our country, unfortunately, industrialisation has been deliberately hampered to favour the business interests of foreigners. This is happening, even now, during the present war, when the undeveloped industrial organisation of India is a handicap to war supplies for the far eastern front. An influential section of Indian political opinion is also against industrialisation ; mainly on the ground of the evils brought in train by uncontrolled machine production. Unless however we have a sufficiency of goods of various kinds produced in our country to meet our requirements, the problem of poverty cannot be solved. At the same time, the production and distribution must be in the interest of the actual producer and the consumer. This can be ensured by control over big industries and by encouraging artisans' co-operatives for production. Competition between large scale factories and producers' co-operative will also have to be replaced by co-ordination through control over industry. If these steps are taken, many of the evils of industrialisation found in Western Europe will be avoided.

In connection with the question of rehabilitation I have so far dealt with the case of peasants. Special mention should however be made of another community, as their case in one respect is comparable to that of peasants, or is even worse. It is that of fishermen. This community is in a very precarious economic condition owing to lack of legal protection of their proper rights. The fishery rights in small rivers or *beels* or even bigger waters is permanently settled areas belong to the tenure holders or Zemindars who lease them out to others. It appears from the Report of the Special Fishery Officer that "there is no limit to what can be exacted" of the actual fishermen, for fishing rights. Even the humble earnings made by fisherfolk in these circumstances was hard hit as the result of the denial policy of 1942-43 which led to over twenty thousand boats being put out of commission. The occupation of fishing, as well as of working as boatmen ceased to be possible in a very large number of cases. These men who had never done any agricultural labour were thrown on a market already glutted by labourers. Yarn needed for nets increased four or five fold, or even more in price, and was impossible to obtain for fisher families, acting in small groups of two or three. Even as late as December 1944 yarn at controlled rate was not available to fishermen in many areas. The Government have authorised, it is understood free grants of rupees fifty or so to a limited number of individual families to help them to re-equip themselves for work. But this will only meet the need as regards nets. Boats are essential for fishing all the year round. Otherwise, fishing has to limited only to the rainy season and a couple of months following it when fish abound in shallow pools by rivers and *beels*, and nets can be used from land for moderate catches. Large number of fishermen in Bengal, who used to fish throughout the year have been reduced to such limited work and forced to supplement their earnings as best as they can as agricultural labourers. It is true the Government are building boats in their yards to send to fisherfolk and boatmen. The quality of timber used is however reported to be unsatisfactory. Even if the boats are of good quality, the price of these will have to be recovered on a long term basis with subventions by Government. Here again co-operatives and co-operative guarantees will be found helpful. Purchase of yarn can also be satisfactorily made through such organisations. A third point which has so far been neglected by Government, is the question of fishery rights. Many fishermen have lost even the little right they enjoyed in these respects, through failure to pay rent during the famine year or even earlier owing to rising prices of food grains and yarn, without a corresponding rise in the price of fish. Restoration of such fishery rights is essential. Another measure in this connection is equally necessary. Zemindars generally settle fishery rights by auction to the highest bidder, who is often a person who employs others to work the *beels* or rivers, or sublets them to actual fishermen at an exorbitant rent. The practice is similar to that of settling vacant holdings with non-cultivating owners, and is even more unjust as there is no legal limit to the fishery rent. These evils ought to be removed by legislation which should enforce priority in the matter of leasing of *beels* and rivers to local fishermen, and failing them, with other fisherfolk. Where there is a local co-operative organisation of fishermen, preference should be given to it.

We have so far discussed the problem of rehabilitation. But it was mentioned in the beginning that the discussion was being carried on apart from the question of short term relief. Owing to the death of a much greater number of able bodied men than of women (roughly twice the number of women), a large section of the population of women and children have been deprived of the earners who supported them. The incidence of sickness has also been high—nearly fifty per cent in the course of a little over a year, and often lasting for months. As the earners have been affected as much as dependants, it is evident that a large section of the population is left without means of support during a good part of the year. Relief, especially for women and children will therefore have to be continued. Medical help also has not so far proved adequate inspite of the work

done by non-official as well as official agencies. It should be extended. Failure to provide sufficient medical relief will accentuate the economic distress and increase sickness in its turn. The disintegration of family life in the more affected areas and the increase in the number of helpless women who are taking to a life of shame, will not be stemmed unless all these measures are seriously taken in hand, and the official and non-official agencies apply themselves to the work, in collaboration. It will be a hard job even then, in the present conditions. But like many other hard jobs it has to be tackled and put through.

NEW NOBEL LAUREATES IN PHYSICS

PROF. OTTO STERN

THE award of the Nobel Prize in Physics for the year 1943 has been made to Prof. Otto Stern of the Research Laboratory of Molecular Physics, Carnegie Institute of Technology, Pittsburgh, for his contribution to the development of the molecular ray method and the discovery of the magnetic moment of the proton. He developed the technique of the method in the Institute for Physical Chemistry in Hamburg before 1933 when he had to leave Germany due to unfavourable political situation. Although beams of neutral molecules moving with thermal velocities were first produced by Dunoyer in 1911, the full realization of the distinctive features of the molecular beam method is due to Stern. To obtain a collision free molecular beam we have to work at very low pressures and the intensity of the beam is very low. Also the energy of the thermal molecules is not sufficient to affect a photographic plate, and the methods available for detecting charged particles cannot be used for detecting neutral molecules. Special methods have, therefore, to be devised for detecting molecular beams. One of the earliest methods is to place a cold target in the path of the beam, the molecules condensing on the target. This was the method applied by Stern and Gerlach in the celebrated Stern-Gerlach experiment which demonstrated the space quantization postulated by quantum theory. The same method of detecting the beam was used by Stern in his experiment on the verification of Maxwell's distribution law, and to detect the pressure of light on a beam of sodium atoms.

The condensation method, however, is not quantitative and does not allow a survey of the intensity within the beam. Stern, therefore, developed very sensitive manometers. A chamber is placed in the path of the beam which is allowed to enter it through a narrow opening. An equilibrium pressure is developed in the chamber, which is measured either by a Stern-Pirani gauge, a surface-ionization detector, or by a space charge detector. From the equilibrium pressure in the vessel, the intensity of the molecular beam is calculated. The equilibrium pressure developed is of the order of 10^{-5} mm. or lower, and the sensitiveness of the Stern-Pirani gauge is so great that it can detect changes of 10^{-9} mm. at a pressure of 10^{-5} mm.

These detectors have been used by Stern in studying the diffraction of molecular beams and other experiments. As is well known, the de Broglie wavelength of a particle of mass m and velocity v is h/mv. This had been experimentally confirmed in the case of electrons by G. P. Thomson and others. Some experiments by Stern and his collaborators on the scattering of hydrogen and mercury beams indicated that the scattering cross-section is much larger than the values obtained on the kinetic theory. This is to be expected if the molecules behave like waves. Direct confirmation of the wave nature was difficult because the molecules from a source do not possess the same velocity and, therefore, do not form a monochromatic beam. Stern and his collaborators managed to select a beam of helium atoms of fairly uniform velocity by passing the beam through narrow slits in two parallel circular discs placed 3 cm. apart and rotating about their common axis. Atoms of the 'correct velocity' arrive in time at the second disc to pass through the succeeding slit, while faster or slower atoms are stopped. The beam then fell upon the surface of a lithiuna fluoride crystal by which it was specularly reflected and diffracted. It was observed that in addition to the reflected beam there was a strong diffracted beam. It was found that the measured wavelength lies within 1·5 per cent. of the calculated value.

This brilliant result was followed by Stern's measurement of the magnetic moment of the proton and deuteron by passing a beam of molecular hydrogen through a strong inhomogeneous magnetic field. Hydrogen consists of parahydrogen and ortho hydrogen in the ratio 1 : 3. In parahydrogen the nuclear spins are antiparallel, and since the two electrons in the molecule also have their spins antiparallel, in a parahydrogen molecule the moment must be due to the rotation of the molecule as a whole. At liquid air temperatures almost all the para-molecules are in zero rotational state (the rotational quantum number $m=0$) and should, therefore, have zero moment. This was experimentally found to be the case, the beam being undeflected in a magnetic field in which the gradient was $\sim 2 \times 10^5$ gauss/cm. At higher

temperatures some of the molecules will be in the rotational state, $m=2$, and hence the deflection experiment at room temperatures allows the determination of the rotational moment per unit quantum number.

If now we perform the experiment with ortho hydrogen in which the nuclear spins are parallel and the lowest rotational quantum number is one, we can allow for the contribution to the moment due to rotation and calculate the magnetic moment of each proton. Stern and his co-workers found this to be 2·46 nuclear Bohr magnetons. A similar experiment with heavy hydrogen enabled them to calculate the magnetic moment of deuteron which was found to be 0·85 Bohr magnetons.

PROF. ISIDOR ISAAC RABI

ISIDOR ISAAC RABI, Professor of Physics, Columbia University, New York, who has been awarded the Nobel Prize in Physics for 1944 for his resonance method for the registration of the magnetic qualities of atomic nuclei has been endowed with the rare gift of combining great experimental skill with remarkable theoretical insight. This is amply borne out by his work on the determination of the mechanical and and magnetic moment of the atomic nuclei.

Rabi's early work was concerned with the determination of the magnetic susceptibilities and application of quantum mechanics to certain eigenvalue problems. But lately he has devoted his attention to the development of the technique of molecular beams and its applications to molecular scattering and determination of nuclear moments. In contrast to Stern, Rabi has generally used a weak inhomogeneous magnetic field as the analyzing field. In a very strong field when the coupling between the electronic and nuclear moments is destroyed we get $(2J+1)$ beams, each beam having the same intensity which is proportional to $(2I+1)$. J defines the extranuclear moment of the atom and I the nuclear spin. In weak fields, *i.e.*, fields which are at atomic distances, smaller than those produced by the nuclear magnet the coupling is retained, and we have $(2I+1)$ $(2J+1)$ beams of equal intensity. A knowledge of J, therefore, enables us to calculate I by merely observing the number of beams. Also the spacing of the beams enables one to calculate the nuclear magnetic moment. This method was first applied to the hydrogen atom.

The net deflection of an atom by the inhomogeneous magnetic field is inversely proportional to its kinetic energy. Since the atoms issuing from source (oven) obey a Maxwellian velocity distribution, there results at the detector an overlapping of beams instead of the formation of sharp lines. To avoid the inaccuracy due to this Rabi developed a magnetic velocity selector. This method was applied mostly to alkali metals. A strong inhomogeneous field first splits the original beam into two (J being $\frac{1}{2}$ in the case of alkali atoms). A slit then selects the slowest of these atoms and passes them on to the weak inhomogenous field where the coupling between I and J is retained. After this the beam is focussed by a field similar to the first, but having the opposite gradient, and it is detected by a surface ionization detector used ballistically to increase the sensitivity.

Another method which was developed at the same time was what we might call the method of zero moments. As we pass from a weak-field pattern to a strong-field one, at certain field values some of the beams pass through the undeflected position. To understand this we shall consider the energy of the atomic magnets in a magnetic field. Confining our attention to the alkali atoms, it can be shown that this energy is a quadratic function of the field, except for the total magnetic quantum numbers equal to $\pm(I+\frac{1}{2})$. The effective quantum number which can be defined as the negative rate of increase of the energy with the field depends, therefore, not only on the magnetic quantum number but also on the field. For each beam there is a certain value of the fields for which the effective quantum number vanishes. If the detector is in the 'no-deflection position' and the magnetic field is increased, we can get the number and spacing of the critical field value. This enables the mechanical and magnetic moments to be calculated.

A further development along these lines has led to the discovery of what is known as "Radio-frequency spectroscopy". The method resulted from an attempt to find whether the magnetic and mechanical moments of the deuteron have the same direction or opposite directions. A beam is passed first through one field and then through another which has the opposite gradient to the first and is of such strength that its deflection is equal and opposite to that of the first. (When this is so the ratio between the effective moments is given by the ratio of the two field strengths. Also, since the effective moments are known functions of the fields, we get two equations between the effective moments which can be calculated.) If a homogeneous field Ho is produced between these two fields, the atomic magnets will precess about this field with the Larmor frequency. If a small (weak) oscillating field of frequency equal to the above Larmor frequency is applied at right angles to the homogeneous field Ho, resonance occurs and the atomic magnets will change their magnetic quantum number. This change is observed at the detector by a falling off of intensity, because the effective moment in the field just preceding the detector changes due to a change in the magnetic

quantum number, and the field does not therefore, exactly counter-balance the deflection produced by the first. A knowledge of the frequency of the oscillating field and the strength of the homogeneous field then enables one to calculate the nuclear Lande g factor and hence the nuclear magnetic moment. An analysis which it is not possible to go into here shows how from the fact whether the transitions to a different magnetic quantum number take place or not one can calculate the direction of the magnetic moment of the nucleus.

The frequency of the oscillating field of course depends upon the intensity of the homogeneous magnetic field and, in actual practice, is of the order of a few thousand magacycles. This new field of 'micro-spectroscopy' can measure energy intervals which are 10^{-5} of the smallest intervals measurable by ordinary optical spectroscopy. By this nuclear magnetic moments have been measured by Rabi and his co-workers with an accuracy of one in a thousand. An important result of the experiments with the hydrogen, deuterium and hydrogen-deuterium molecules has been the discovery that the deuteron is not spherically symmetrical in shape but elongated along the spin axis (*i.e.*, has an electrical quadrupole moment).

Prof. Rabi was awarded the 'Thousand Dollar Prize' by the American Association for the Advancement of Science in 1939 in recognition of his brilliant work in throwing light on the properties of the subatomic units.

R. N. R.

GOVERNMENT SCHEME FOR TECHNICAL TRAINING OF STUDENTS ABROAD

IN response to numerous enquiries being received from students desirous of proceeding overseas for courses of study in the near future, following the recent announcement, by the Hon'ble Member for Planning and Development, of the Government decision to send abroad about 500 students for training in technical subjects directly related to the various plans for post-war development, the Department of Education, Health and Lands has just issued a press communique to which we draw the attention of our readers. Some of these students will be selected direct by the Central Government ; others will be selected in the first instance by Provincial Governments. In the former case the Central Government will provide the financial assistance required to enable the students to complete an approved course. In the latter case the cost of such financial assistance will be shared equally between the Central and Provincial Governments. The selected students will be required to give an undertaking that on completion of the course abroad they will enter such employment in this country as may be indicated by the Central or Provincial or State Government as the case may be. Although no guarantee can be given, every effort will be made on the student's return to this country to find him employment on terms commensurate with the qualifications which he may have obtained.

A special selection committee will be established by the Central Government to deal with applications received. It has been suggested to Provincial Governments to appoint similar selection committees in Provinces. Special arrangement will also be made to place the students selected in suitable universities or similar institutions abroad and to look generally after their welfare while they are overseas. Free passages and reasonable travelling expenses from India to the institution selected will be provided as well as return passages on the satisfactory completion of the prescribed course. The main courses for which awards will be available are set out below :—

1. Agricultural Subjects (including Animal Husbandry).
2. Educational Science and Practice.
3. Mechanical Engineering.
4. Electrical Engineering.
5. Civil Engineering.
*6. Chemical Engineering.
*7. Aeronautical Engineering.
*8. Marine Engineering.
*9. Architecture, Regional Planning, Building Construction.
10. Applied Chemistry (including preservation and distribution of food stuffs).
11. Applied Physics.
*12. Geology.
*13. Metallurgy.
14. Other forms of Applied Science.
15. Technical subjects not covered above.

Courses other than those set out above will be considered only if directly related to probable post-war needs.

(*N. B.*—Separate arrangements are being made by the Central Government in consultation with Provincial Governments in the case of students who may be sent abroad, for courses in Medical subjects. These will be announced shortly.)

The numbers selected for each course will be strictly limited and will be determined solely by post-war requirements. Preference will normally be given to students who have already completed a degree at a university in India or elsewhere, but this will not apply to students who possess special qualifications or experience that would make them suitable for one of the courses specified above. Advertisements inviting applications will shortly be issued by the Government concerned, and applicants residing in a Province are advised to comply with the

instructions which will be contained in these advertisements as to the method of submitting applications. Applicants resident in the Centrally administered areas or areas administered by the Crown Representative (or those for awards for courses starred above) should submit their applications to the Secretary, Education, Health and Lands Department, Government of India, marked "OVERSEAS STUDENTS".

The subjects starred on the above list at present concern the Central Government only, but there are other subjects in which both the Central and Provincial Governments are interested. Applicants for courses in these subjects may submit their applications either to the Central Government or to their Provincial Government.

In the case of students desirous, as in the past, of proceeding abroad for study at their own expense, and of those likely to be sent by firms, private bodies or persons, the Government of India are anxious to provide advice and guidance on a much larger and wider scale than they did hitherto. With this end in view, the Central Government have asked Provincial Governments and universities to set up Students Advisory Bureaux as soon as possible with a view to affording such advice and assistance. It is also Government of India's intention to establish machinery for helping these students to obtain admission to university and other institutions abroad and for looking after them generally during their stay in the foreign country. It is, therefore, suggested that all students who desire to proceed abroad at their own expense for courses of study as soon as travelling conditions permit, should ascertain from their Provincial Governments or from their universities whether such Advisory Bureaux or Committees have been established, and if so, should take full advantage of the facilities offered. It is intended that these Advisory Bureaux should deal with all students, other than sponsored students, whatever the nature of the studies they may intend to pursue abroad.

It should be emphasized that the arrangements set out above apply only to British Indian subjects and not to subjects of Indian States. It is understood that a number of Indian States contemplate making similar arrangements. So far, however, as the placing of students in institutions abroad and looking after their general welfare are concerned, the machinery referred to above will be available for those students from Indian States who desire to take advantage of it.

Notes and News

INDIAN SCIENCE CONGRESS

THE 32nd annual meeting of the Indian Science Congress Association was opened on Tuesday, January 2, 1945, by His Excellency Sir Henry Joseph Twynam, K.C.S.I., C.I.E., I.C.S., Governor of Central Provinces and Berar and Patron-in-chief of the Congress at the College of Science, Nagpur, in the presence of a large gathering of delegates, members and visitors.

Lt. Col. the Hon'ble Justice W. R. Puranik, B.A., LL.B., Vice-Chancellor, Nagpur University and Chairman of the local reception committee, requesting His Excellency to inaugurate the sessions, extended a cordial welcome to the delegates and visitors at Nagpur. Referring to gifts of science and its application in the present world conflagration, Justice Puranik said:

"Numerous and variegated weapons are raining destruction on the human species. Machine guns, submarines, flame-throwers, torpedoes, incendiary bombs, delayed action bombs, rocket plane, and V-1, V-2, etc.,—these strike our bodies and confuse our minds and even depress our spirits. But the gifts of science, like gifts of Heaven, are always double-edged. Their value depends on the purposes which they are made to serve. So far, therefore, as any charge of responsibility for the horrors of the present war is concerned, the scientist deserves, in my judgment, an honourable acquittal. If the gifts of science have been abused, should science not ponder over the ways and means of preventing that abuse in future? This takes us to the problem of the relation of science to society. If science could impart something of its objectivity to our politician and diplomats and administrators, who so largely make or mar the fortune of man on the globe, many of our problems would not only be solved but would not even arise."

"The material problem for our country in the immediate future is not so much to reach the maximum that man is capable of; it is rather to reach the minimum below which no man in the twentieth century should be expected to live. In the midst of all the manifold plans that are being unfolded before us from day to day, the central fact remains that the standard of living in India has to be pulled up and pulled up with an enormous concentrated vigour; that effort will require both good will and wealth but it will also require wisdom, and for this we confidently look forward to Indian Science. To devise the most economic ways of using the resources that are already being tapped and of tapping the resources still untapped, and thus to enable us, one and all, to live a richer life—these

are the tasks that await us and, I have no doubt, that they will be duly discharged at your hands."

H. E. Sir Henry Twynam, addressing the meeting, said :

"The present war has been rightly described as a revolution rather than a war. It is a revolution which challenges all old established outlooks, and both conflicting ideologies of Fascism and Communism have been largely influenced by the scientific approach. Mankind is looking earnestly towards a future in which sentiment and romance will be superseded by science and technology".

All of us, he added, were keenly aware of what had been achieved in Russia by the application of science and technology to countries which until recently were living in the bullock-cart age. Even in Central Asia, in Bokhara, and Samarkhand the tractor and mechanical transport had taken the place of the bullock-drawn plough and bullock-cart.

Since war, the Governor went on, the pragmatical approach to the problems with which we are confronted has completely driven *laissez faire* from the field of human thought, and the conferences which have taken place at Dumbarton, Hotsprings and elsewhere indicate the extent to which scientific method is all along the line.

"We are groping our way towards a planned economy not only in the fields of agriculture and industry but also in the wider field of human relationships generally."

"I, for one, welcome the discarding of old shibboleths and the substitution for them of new ideals based on principles of not so much the greatest happiness of the greatest number as the greatest material well-being of the greatest number."

The Governor then read a cable from Sir S. S. Bhatnagar from Washington, regretting his inability to attend and hoping that the experiences gained in the United Kingdom and the U. S. A. by his delegation would result in recommendations likely to lead to great scientific developments in India.

Prof. S. N. Bose then read the presidential address of Sir Santi Swarup Bhatnagar (see *Science and Culture*, January, 1945, "Science Congress Supplement").

HARNESSING THE DAMODAR

"The Government of India have very much in their mind the Tennessee Valley scheme operating in the U. S. A. . . The Damodar Valley is the first project along this line. The authority which will be in charge of this project after it is completed will be more or less modelled, as far as it may be possible, on the Tennessee Valley Authority." Thus observed Dr B. R. Ambedkar, presiding over the conference of representatives of the Central, Bengal and Bihar Governments, held in the first week of January at Calcutta to consider how best to give effect to the proposals of the Damodar River Flood Enquiry Committee appointed last year by the Government of Bengal. The recommendations of the Committee that the rivers of India should be made the concern of the Central Government and that the Government, while undertaking the project of damming the Damodar, should have a multi-purpose policy so as to include provision for irrigation, electrification and navigation found favour with Dr Ambedkar. He referred to the improper and erroneous distinction between railways and waterways, as a result of which the railways are treated as a Central, and waterways as a Provincial subject. Like railways, the waterways in most cases flow through more than one province, but limitations of Provincial Autonomy have often prevented utilization of valuable water resources, as such endeavour would involve two or more disagreeing provinces. A province requiring electricity and intending to utilize its water resources 'cannot do so because the point at which water can be dammed lies in another province which being agricultural does not need electricity and has no interest in it or money to finance the project, and would not allow the needy province to use the site'. Further, the Government's waterways policy has so far been one of irrigation, but henceforward generation of electricity and promotion of navigation should also be the purpose of waterways policy.

The Government's intention to revise their waterways policy has been somewhat reflected in their recent creation of a central organization called the Central Technical Power Board. They are further contemplating the creation of another to be called the Central Waterways, Irrigation and Navigation Commission. The Government of India, as Dr Ambedkar revealed, are keen on following the example of T. V. A. in harnessing the Damodar river, which will be a co-operative undertaking in which the Centre and the provinces of Bihar and Bengal will be partners.

At the conference the representatives discussed a note circulated by the Government of India about the procedure for collecting necessary information. It was suggested in the note that the three Governments should prepare an inventory of facts and figures in consultation with Central Government's technical experts. This would then make possible the preparation of a preliminary memorandum setting out the prospects for a co-ordinated scheme for the multi-purpose development of the Damodar Valley. The Governments involved can then give necessary instructions to technical experts for framing a project. The representatives generally agreed to the desirability of making the Damodar scheme a multi-purpose project and also endorsed the lines set in the note, along which investigations should start, representatives from Bengal, however, emphasizing the primary importance of flood control in the scheme.

It was decided that such investigations would start under Mr Man Singh, special engineer (Irrigation) with the Government of Bengal.

INDUSTRIAL PANELS

We learn with satisfaction that the Department of Planning and Development will find it possible to bring into existence a number of industrial panels within a short time. The panels which are expected to be set up soon include iron and steel (major), sugar, alcohol and food, and heavy chemicals, light chemicals and electro-chemical industries. While creating these panels, an 80% to 100% increase in the production of iron and steel, 50% in textiles and 100% in cement are aimed at in course of the next five years. The panel for iron and steel, which, it is understood, will include Sir P. Ginwala (Chairman), Sir J. J. Ghandy, Mr Bashir of Cawnpore and Mr Parr, Steel Commissioner, will have the following for its terms of reference: alloy steel, special steel, tools steel, re-rolled products, fabricated and structural steel, forgings, castings, tubes, tin plates, wire, nails and screws, nuts and bolts. For the textile industry, the existing Textile Board will function as the panel.

Each panel will be required to report on the scope and extent of development and suggest whether the industry should be State-owned, either on grounds of national interest or because of the unwillingness of private capitalists to undertake it. It should further advise on the capital required for development, the extent to which foreign technical advice may be necessary, the manner and degree of co-operation with foreign firms both as regards capital and management, the location of the industry, the nature of assistance required from Government in the form of protection duties, bounties, research grant, expert advice etc., the control Government should exercise in the case of private ownership, whether the industry should cater for the export market, and finally whether it should develop, as in Japan, on the cottage industry basis and if so, to what extent.

The panels will be supplied with all possible factual information by the Government regarding existing industries as well as new ones. It is understood that joint meetings of the panels will be held, whenever necessary, to secure co-ordination, particularly where some connection exists between the processes and products of two or more industries.

INSTITUTE OF FERMENTATION TECHNOLOGY

The *Journal of Scientific and Industrial Research*, in its December (1941) issue, made a strong plea for the establishment of the Institute of Fermentation Technology, now under contemplation. One of the primary objects of the Institute will be in the training of fermentation technologists and industrial microbiologists capable of undertaking research and development work and ultimately taking charge of industrial operations. The existing industries are in need of a large number of fermentation specialists whose demand will steadily grow with the expansion of the industry. Similarly the pharmaceutical and food industries which are now being established will require the services of industrial microbiologists for whose training facilities are now almost non-existent. According to an estimate, several industrial organizations of the country can at present absorb some 250 such specialists with advantage. The Fermentation Technology Section of the Indian Institute of Science, however, trains up specialists of this type; but in view of its limited facilities it is unable to cope with the great demand which can alone be met by an institute of the type now contemplated. In addition to the training of fermentation specialists, the Institute should have to undertake study and research on the fundamental aspects of fermentation biochemistry and microbiology. It is further suggested that the Institute should also be provided with a chemical engineering laboratory and a pilot plant house.

The Council of Scientific and Industrial Research have encouraged study of industrial fermentations from its very inception and also allotted funds, early in 1940, for the organization and maintenance of a National Collection of Type Cultures at the Indian Institute of Science, Bangalore. They also constituted a research Committee to attend to all scientific questions connected with fermentation processes.

The Institute of Fermentation Technology, when it comes into existence, will provide a great fillip to the fermentation industries in India. Only two such industries, namely the brewing and the distillation industries, producing alcoholic beverages and industrial alcohol respectively, have so far been established, which are far from meeting the demands of Indian market, either in quantity or in quality. Alcoholic beverages worth 2·5 crores of rupees are annually imported to this country, while we have to largely supplement indigenous production of industrial alcohol with supplies from Australia and South Africa. This is a pointer to the great possibilities and prospects of these industries in India. In Europe and America, fermentation industries which provide industrial solvents, organic acids, vitamins and vitamin concentrates, yeast and protein foods, penicillin-like drugs and a large number of other commercially valuable chemicals have come to assume a unique place in their industrial structure. We hope that the question of an early establishment of the Institute will receive the most urgent consideration of the Government of India.

COSMIC RAY EXPEDITION TO THE PAMIR

ACCORDING to *Science*, October 13, 1944, an expedition of a group of scientists from the Lebedev Institute of Physics of the U.S.S.R. Academy of Sciences, under the direction of Professor D. V. Smobeltsyn, has recently been led to the Pamir Mountains to study cosmic rays at high altitude. The expedition was sponsored to continue studies that had been carried on for several years at the Atomic Nucleus Laboratory on Mount Elbrus, the highest mountain in the Caucasus. Located in Southern Russia, the Pamir Mountains extend both into Afganistan and India. The principal investigations of these scientists will include the study of the composition of cosmic radiation at high altitudes and of the role played by heavy particles and secondary mesons. The expedition will make use of a perfected proportional counter telescope and improved methods developed in the Atomic Nucleus Laboratory.

METEORITE EXHIBITION IN MOSCOW

A REPORT of *Sky and Telescope*, prepared from a cablegram received from the Soviet Scientists Anti-Fascist Committee, informs that a permanent meteorite exhibition has been opened in the Karpinska Geological Museum, Moscow. The meteorite collections of the Academy of Sciences, consisting of more than 1,200 specimens obtained from some 200 meteorites which have fallen both within and outside Russia, have been exhibited. The exhibits include the 10 largest of the meteorites, of which the pallasite iron specimen weighing upwards of half a ton was found in 1734 on the banks of the river Yenisei in Siberia. There is also on display the Kainzas meteorite, the largest of about 20 stones which were found after the meteorite shower of September 13, 1937. It weighs 102·5 kilograms, while the smallest stone of this shower weighs 7 kilograms. The largest iron meteorite in the world—two pieces, one weighing 199 kilograms and the other 58 kilograms, are also exhibited. Small specimens illustrating the shapes of meteorites and types of crusts and surfaces are exhibited in a special case. Particular interest attaches to the meteorite's steamlined shape resulting from the melting and flowing of its forward surface as it collides with the resisting atmosphere. This has been illustrated in the case of Karakul stone meteorite which fell on May 9, 1840, in Semipalatinsk province, and in the Repeyev Khutor iron which fell on August 8, 1933, in the Stalingrad region. The meteorite structure and composition constitute the attraction of another case. About 100 stones with a total weight of 65 kilograms were found after a shower in the Ivanov region on December 26, 1933. These exhibits are associated with tables showing the chemical and minerological compositions and with diagrammes, illustrating the process by which meteorites break up into showers by atmospheric friction.

WARDHA BASIC EDUCATION CONFERENCE

A FOUR-DAY conference of educationists, professors and teachers was held at Sewagram, Wardhaganj, under the presidentship of Dr Zakir Hussain, to review the progress made in the past years in the experiment on basic education in various provinces and states of India, and recommend future course of action. The scheme of basic education which seeks to educate the young boys and girls of ages between 7 and 14 through craft and manual labour and mother tongue started in 1937 through the institution of Hindusthani Talimi Sangh. The main feature of this education is that the students are simultaneously required to take up profit-yielding vocation to enable them to pay for their dues through the products of their labour. This serves, according to the promotors of the scheme, the useful purpose of developing the whole man through the vocation learnt at the school. The conference expressed satisfaction at the progress made in the basic education experiments and recommended that the Hindusthani Talimi Sangh should give full consideration to the question of undertaking both pre-basic and post-basic education in order to make the scheme of basic education complete in itself and much wider in scope. It recommended that the Sangh should appoint a committee to draw up a scheme of pre-basic education for boys and girls below 7 years of age, which will serve as foundation for basic education. In its recommendations for post-basic education, the conference drew attention to the urgency of (1) drafting a suitable syllabus for part-time continuation of courses for those intending to live a fuller life and acquire further proficiency in their craft, and (2) devising a diversified system of institutions to provide whole time education for various aptitude types, keeping in view the needs of national life. The conference was of opinion that educational institutions in the villages should produce articles which are useful and at the same time of true educational value in order to enable the adult pupil to earn wages enough to defray his cost of education. This implies that the economic order of the country will have to be simultaneously revolutionized so as to make possible an all-round increase of wages. The primary object of production should be internal self-sufficiency of the nation, and, to achieve this, technical research should be undertaken to make decentralized and small-scale production economically successful.

HYDRO-ELECTRIC PROGRESS IN CANADA

CANADA has, during the last few years, made a gigantic stride towards developing hydro-electric power whose utilization has given her a status as an industrialized country, hitherto unknown in her his-

tory. According to a review of her hydro-electric progress in the *Beama Journal* (June, 1944), we learn that Canada's total installation stood at 10,214,513 h.p. at January 1, 1944. For Canada's total of 11,812,000 (June 1, 1943), this amounts to an average installation of about 865 h.p. per 1000 population. And yet this development accounts for only 20 per cent of the country's estimated water power resources, leaving 80 per cent. for future development as demand increases. Distribution of power installations is mainly indicated under three headings, *e.g.*, central electric stations, pulp and paper mills and other industries. Central electric stations which account for 9,221,599 h.p., or 90·3 per cent. of the total hydel installation represent the power developed for the sale of electricity to meet general, industrial, commercial, municipal, domestic and agricultural demands. More than 98·5 per cent. of all electricity produced for sale in Canada or for export to the United States is generated from water power.

Pulp and paper industry comes next as an important consumer of electricity. The industry has an aggregate hydraulic installation of 642,576 h.p. or 6·3 per cent. of the total. The industry further provides the greatest individual peace-time market for the power produced by the central electric stations. Canada is a leading newsprint manufacturing country, her production of newsprint being 3 times that of the U.S.A. and constituting about 72·1 per cent. of the total North American production (1942). The great consumption of electricity by the industry will be realized from the fact that a mechanical power installation of nearly 100 h.p. is required per ton output of newsprint. 95 per cent. of the power used by the industry is hydro-electric.

The remaining 350,338 h.p., or 3·4 per cent. of the total hydraulic installation account for mineral industries, electro-chemical plants, electric railway plants, and the large number of saw, grist, and grinding mills and other manufacturing industries. Although some mining and metallurgical industries have their own installations, these industries generally use power supplied by the hydro-electric central stations owing to the low cost and dependability of their power. More than 80 per cent. of the power requirements of her metal mining and metallurgical industries is met by purchased electricity. Canada leads the world in the production of several metals, such as asbestos, nickel, platinum and probably radium ; she is the second largest producer of gold and comes third in the production of silver, copper and zinc and fourth in lead. Canada's abundant water power resources make available power at a cost which permits of economic mining of large quantities of comparatively low-grade ore and the application of large-scale electro-metallurgical processes for the recovery of the metals.

TECHNICAL INSTITUTES AND POST-WAR DEVELOPMENT OF INDUSTRY

'THE place of the Technical Institutions in the Schemes for Post-War Development of Industry in India' formed the subject of the presidential address of Mr R. A. MacGregor, the retiring president of the Mining, Geological and Metallurgical Institute of India, at its thirty-ninth annual general meeting held in the rooms of the Royal Asiatic Society of Bengal on January 12, 1945.

He explained that the Government of India, through the Department of Scientific and Industrial Research, had made a grant of a crore of rupees, supplemented by a considerable sum from private sources, for the establishment of a number of research laboratories throughout India. The ones most particularly interesting to the Institute were the National Metallurgical Research Laboratory at Jamshedpur and the Fuel Research Station at Dhanbad. He suggested that the same arrangement holding good in U. K. and U. S. A. should be adopted in India. The results of research work issuing from the National Laboratories should be presented to technical institutions throughout India. In this way the greatest publicity would be obtained for the work done, and mutual advantages would accrue to the research workers as well as the industrialists.

Unfortunately, in India, the technical institutions have not yet grown to such a size that they can afford to run their business on anything but voluntary lines, and, as a consequence, there are distinct signs of lack of continuity of policy. Therefore, in view of the advantages to be gained by the research laboratories and the country as a whole, it was suggested that the D. S. I. R. should appoint permanent secretaries in the Delhi, Calcutta, Madras and Bombay areas, who would carry out the routine work of Government recognized technical institutions in their areas. Permanent secretaries of this nature would ensure continuity of policy and would act as liaison officers between the research laboratories and the technical institutions. The professional status of the institutions should, however, remain as heretofore. It was pointed out that the rise of modern industrialization in the West could be traced very largely to the British Royal Society founded in 1663. From the Royal Society many highly specialized technical institutions have branched off in succeeding years, but over the last thirty years there is a decided tendency, both in U. K. and U. S. A., for the specialized institutions to link together again. The reason for this is that the interests of all branches of engineering are overlapping more and more, as a higher state of development is reached.

At the beginning of her drive towards industrialization, India now has a unique opportunity of

linking her research organizations and technical institutions and so of bringing about that desirable state wherein the course of research is guided into channels of greatest value to the new industries. Further, industry has every opportunity of correctly informing itself on current scientific development. Not the least of the advantages to be gained from this linkage is the kind of post-graduate education of the student members who will have the chance of hearing, or joining in discussions between the research-worker and the mature professional engineer.

The new Council was elected at the meeting, and following are the office-bearers for the ensuing year: *President*: Mr B. Wilson Heigh; *Vice-Presidents*: Mr L. J. Barraclough, Dr H. Crookshank and Mr B. Sen; *Honorary Treasurer*: Dr H. Crookshank; *Honorary Editor*: Mr E. J. Bradshaw; *Honorary Secretary*: Mr A. Reid; *Local Secretaries of branches*: Dr C. Forrester, Dhanbad Centre; Mr J. H. Paterson, Asansol Centre; Dr J. Sanjana, Jamshedpur Centre; and Mr T. A. Wellsted, C. P. Branch.

POLLEN BANK

At the 24th annual meeting of the Indian Botanical Society held at Nagpur on January 3, 1945, Dr P. Maheshwari, Vice-President of the Society, in delivering his presidential address entitled "The Place of Angiosperm Embryology in Research and Teaching", referred to the development of embryology as an experimental science during the last two decades. This branch of science includes the study of such problems as the storage of pollen and its germination, the receptivity of the stigma, fertilization and fruit-setting, and the optimum conditions required for this.

He envisaged the possibility of opening one more "Pollen Bank" in each country where pollen of almost every important plant of economic value could be stored under optimum conditions and supplied to recognized workers, free of, or on a moderate charge. It is said that the Arabs put aside the pollen of date palm from year to year so as to ensure a supply of dates even in the possible event of the male flowers failing to develop or the female flowers developing precociously.

Experimental embryology is full of promise; for a scientific explanation of his successes and failures, the breeder must turn to the cytologist and embryologist. The work on the effect of X-rays, heat, chemicals etc. on the artificial induction of mutations is still in its infancy, but it opens up vast possibilities before us. "Hear the breeder, the cytologist, the embryologist and the physiologist must all join hands, so that not only do we get the maximum results from what we have but we may evolve new and still better varieties of plants and add to the health and happiness of the world."

The following were elected to the various offices for the year 1945: *President*—Dr N. L. Bor. *Vice-Presidents*—Prof. H. Chaudhuri, Dr B. P. Pal. *Secretary*—Dr S. N. Das Gupta. *Treasurer and Business Manager*—Dr A. C. Joshi. *Elected Members of the Ex. Council*—Dr P. L. Anand, Prof. F. R. Bharucha, Prof. M. O. P. Iyengar, Dr T. S. Mahabale, Prof. G. P. Mazumder, Prof. R. L. Nirula, Dr P. Parija, Dr T. S. Raghavan, Prof. L. N. Rao, Prof. M. Sayeed-ud-din. *Editorial Board*—Prof. S. P. Agharkar, Prof. H. Chaudhuri, Dr S. N. Das Gupta, Prof. M. O. P. Iyenger (*Editor-in-Chief*), Dr A. C. Joshi, Dr P. Maheshwari, Prof. G. P. Majumder.

NEW DIRECTOR OF INDUSTRIES, BENGAL

Dr Ali Karim, Ph.D., D.I.C., A.I.C., A.M.I. Chem.E., whose appointment as the Acting Director of Industries, Bengal, has been recently announced, has a remarkable career. A graduate in science of the Calcutta University, he went to England in 1923, after receiving a Government scholarship, to prosecute higher studies in the Department of Chemical Technology of the Imperial College of Science and Technology, London. He carried on research in oils and fats, in theoretical and practical fuel technology and in chemical engineering. The London University conferred on him the Ph.D. degree in Chemical Technology. On his return to India in 1927, Dr Karim was appointed Chief Works Chemist in the Shalimar Paint, Colour and Varnish Works. In 1933, he again proceeded to England for a further period of 3 years to conduct research on lac and allied products in a scheme sponsored by the Imperial Council of Agricultural Research, Government of India, and worked in the British Paint Research Station at Teddington. In 1937, after his return from England, he was appointed Deputy Director of Industries and Industrial Engineer, Bengal. We wish him a successful career in his new post.

LADY TATA MEMORIAL TRUST RESEARCH SCHOLARSHIPS FOR 1945-46

The Trustees of the Lady Tata Memorial Trust are offering eight Scientific Research Scholarships of Rs. 150/- each per month for the year 1945-46, commencing from 1st July 1945. *Applicants must be of Indian Nationality and Graduates in Medicine or Science of a recognized University.* The subject of scientific investigation must have a bearing, either directly or indirectly, on the alleviation of human suffering from disease. Applications must reach by March 15, 1945. Further particulars can be had from the Secretary of the Trust, Bombay House, Bruce Street, Fort, Bombay.

SCIENCE IN INDUSTRY

SUGAR-BEET EXPERIMENTS IN RUSSIA

In a recent issue of *Discovery*, Prof. Valentine Ditiakin has briefly reviewed the experiments conducted in the U. S. S. R. on the cultivation of sugar-beet in the northern latitudes. Although the southern regions of the U. S. S. R. constitute the basic sugar-beet areas, attempts have been made to push the beet cultivation increasingly to the northern regions with conspicuous success. One hundred and fifty years ago, it was difficult to produce beet with 6 per cent sugar content; beets with sugar content of about 20 per cent have now been produced in Archangel, Vologda, Leningrad and Molotov and the Sverdlosk regions, the yields per acre averaging from 20 to 28 tons. The yield, however, declines beyond the Arctic circle, and at Naryanmar, at the mouth of the Pechora River, yields of 6 tons per acre have been obtained, while in the Snoloversk Islands (Lat. 65°N), there was no difficulty in raising an yield of 18½ tons per acre with 17 per cent sugar content. The Tula and Ryazan regions are, however, regarded as the northernmost limit of the sugar-beet areas, as its successful cultivation requires 5 frostless months.

The results of investigations indicate that special importance attaches to timely planting. Monthly sowing, although it involves arduous labour, is recommended mainly for the northernmost districts and small gardens. In the north, beet grows and sugar continues to accumulate till October 1st, and as such the crop may be safely harvested early in October, as it does not sustain any loss due to the incidence of early cold. Timely planting is particularly important in the case of spring crop, since even a small delay may appreciably affect the yield. It has been observed that a delay in planting by 20 days may lead to a decline in yield by 1·6 to 1·8 tons per acre.

Constant digging of the soil between the rows to keep it mellow during summer is calculated to maintain the high level of sugar content in beet. The northern soils are generally poor and acidic and as such favourably responds to organic fertilizers and lime treatment. An increase in the yield by 1·6 to 2·4 tons per acre results from the application of manure (8 to 16 tons per acre), and treatment with lime frequently doubles the return. The mineral fertilizers have been employed with great advantage. sub-feeding with nitrate fertilizers, which increases the yield from 1·2 to 2 tons per acre, has been found to be the most effective.

INFRA-RED LAMPS IN INDUSTRY

The application of infra-red lamps for heat treatment in industry is a very recent development. The experts are inclined to attach great importance to this new application which has remarkably speeded up industrial heating. The disadvantages of convection heating employed for paint drying and other industrial processes are well-known, the chief of which consists in its having an unusually long drying time. For paint drying, for instance, the stoving time often extends to an hour or more. In marked contrast to this, heat treatment with infra-red lamps has reduced this time to a few minutes. Owing to its great gain in speed, the new process of radiant heating has now been employed for drying paints and varnishes, foundry moulds, and powders used for plastics, and also for the softening of plastic sheet with great advantage. This, however, does not exhaust the list of its applications, which is steadily growing.

Resembling tungsten filament lighting lamps in appearance, the infra-red lamps differ in construction and operate at a lower filament temperature so that the maximum energy may lie in the infra-red part of the spectrum. An efficient source of radiant heat, the lamp has a small filament and contains inert gas which protects the filament and also reduces the convection loss. The lamps are provided with reflectors of infra-red rays, whose design and construction deserve mention. Originally, lamps used to be individually provided with round reflectors plated with pure gold which reflects infra-red rays with great efficiency. The individual reflectors have now been replaced by trough reflectors which permit of closer lamp spacing with the consequent increase in heating intensity. Further, trough reflectors are now plated with rhodium instead of with gold,—an improvement which has the advantage that, compared to gold, rhodium is a hard metal highly resistant to wear and abrasion.

One type of the paint-drying unit manufactured by the G. E. C. consists of six trough reflectors, each having 9 Osram infra-red lamps, with a total consumption power of 13·5 kW. Another much larger infra-red heating plant designed for drying paint inside and outside petrol containers by the same manufacturer employs more than 2000 lamps and operates on a total load of 450 kW. The Osram infra-red industrial lamps are rated at 250 watts.

In radiant heating, the article absorbs energy at or immediately beneath the surface receiving heat,

and consequently surface conditions greatly determine the temperature to be attained by the article. The conductivity of the material of which the article is made also has a part to play in the attainment of temperature. Maximum temperatures of the order of 600°F are easily attainable by metal articles in a few minutes in the new process employing infra-red lamps. With convection heating, on the other hand, the articles may even fail to reach the maximum oven temperature at all, not to speak of the comparatively long heating time involved in the process.

As already mentioned, the various industrial applications of infra-red lamps include paint drying, coil drying, drying foundry moulds, softening plastics, accelerating setting of adhesives and many others. Paint drying, however, represents by far the most important application of radiant heating. The drying time depends on the nature of the article and of the paint used, but in all cases, with infra-red heating, ten minutes are regarded as a long time, many paints drying up in less than a minute or two. Reversible paints, such as spirit varnishes and cellulose derivatives where the solvent vaporizes, dry up relatively quickly. Irreversible paints, including synthetic resin, which undergo chemical reactions during drying, may require a slightly longer time.

Coil used for electrical appliances, such as small transformers and motors, require to be coated with insulating varnishes which may be advantageously dried with infra-red lamps. Drying time for such varnishes necessitating a maximum temperature of about 300°F is greater than that for paint drying. But whereas a full day may be needed in processes employing convection heating, infra-red heating requires only 2 to 3 hours.

Various methods, including convection ovens and gas torches, are available for drying sand moulds for metal castings. While some are slow, others require skill on the part of the operator. Infra-red heating may be particularly recommended for such moulds as require surface heating and possess a configuration favourable for direct irradiation. The drying time ranges from 5 to 45 minutes, depending on the nature of sand, its moisture content etc.

Plastics, such as bakelite, perspex and cellulose acetate, require to be softened by heating before moulding and punching and lend themselves to infra-red heating which does the job within a half to a few minutes. Radiant heat has been applied with great advantage in drying synthetic glues used in the prefabrication of wooden assemblies in the aircraft and furniture industries. By raising the temperature of the glue line to 160°F, drying may be effected in about 15 minutes compared to 5 to 6 hours for the glue to set at room temperature.

Numerous as the applications of infra-red industrial lamps are—and many more are being added to almost daily—it must not be supposed that radiant heating lends itself to all problems of heating, for which better processes indeed exist. (References: *Discovery*, September, 1944; *Beama Journal*, June, 1944).

S. N. S.

PARIS GREEN

The two Russian chemists, G.P. Luchinskii and V. F. Churilkina, (*Russian J. Appl. Chem.*, *13*, 367) have recently devised a method of preparing Paris green, the important insecticide and also known as Schweinfurth green, which has been abstracted in *The Chemical Age*, September 23, 1944. The insecticide is now prepared by dissolving white arsenic in soda lye and then mixing the solution with acetic acid and copper sulphate. This process involves the waste of whole of the soda employed in the form of sodium sulphate. No such waste takes place in the method evolved by the Russian chemists, which is reported to have passed the pilot-plant stage.

In the new process the starting chemicals are acetic acid, copper oxide and arsenic trioxide, and the reaction takes place according to the equation: $4\ CuO + 3As_2O_3 + 2\ CH_3\ COOH = 3\ Cu\ (AsO_2)_2.\ Cu\ (CH_2CO_2)_2$. Theoretically, 1000 parts of Paris green are obtained from 314 parts of copper oxide, 586 parts of arsenic trioxide, and 118 parts of acetic acid. In practice, 236 parts of glacial acetic acid are mixed with 2800 parts of water in a pot provided with a reflux. 314 parts of copper oxide are added and the mixture is heated to boiling. 586 parts of finely ground arsenic trioxide are introduced into the boiling liquid and the mixture is continuously stirred. Cooking takes place for about 2 hours, after which the mixture is cooled for one hour and then filtered. The filtrate contains some copper and arsenic which should be taken into consideration when the filtrate, after addition of more acetic acid, is used for further preparation. The crude paste thus obtained is washed and finally dried when Paris green is obtained.

It is suggested that copper oxide should be prepared by heating copper powder in air at a temperature below 300°C. It is further observed that copper oxide prepared at a higher temperature is not sufficiently active. The oxide must not, however, be made by allowing an alkali to react with copper sulphate, as it would defeat the very purpose for which the sulphate has been replaced by the oxide.

SODIUM CHLORITE AS A REAGENT FOR THE ESTIMATION OF CELLULOSE

P. B. SARKAR and H. CHATTERJEE,

INDIAN CENTRAL JUTE COMMITTEE, TOLLYGUNGE, CALCUTTA

THREE different methods are commonly employed for the estimation of cellulose in plant materials, namely, Cross and Bevan's, Schmidt's, and Norman and Jenkins's. None yields 'pure' ('true' or α-) cellulose,—the product in each case being associated with varying amounts of hemicelluloses, including uronic anhydrides and pectin. Highest yield of cellulose is obtained by the ClO_2 method of Schmidt ; Norman and Jenkins' method comes next, and Cross and Bevan's method last—so far as yield of cellulose is concerned (vide Table II). The amount of α-cellulose (calculated on the raw material) prepared from the latter two celluloses is, however, practically the same, showing that the resistant or α-cellulose portion of the cellulose is not affected by the reagents employed. That from Cross and Bevan's method is somewhat lower.

The composition and structure of the hemicelluloses are not yet definitely known ; far less definite is our knowledge regarding their mode of combination, if any, with pure cellulose. In recent years, xylan (and in some cases, also mannan, etc.) has been considered by Norman and others as an 'integral part' of true cellulose on account of the difficulty of their isolation, while polyuronides are regarded as incrustants, like lignin. Norman and Jenkins[1] designate xylan and other polysaccharides intimately associated with true cellulose as 'cellulosan'. Their method of estimating cellulose is apparently based on the removal of lignin and polyuronides from plant materials, what is left behind is believed to consist of true cellulose and cellulosan. From their results, it is found that very few samples of isolated cellulose (from straw and wood) were completely free from lignin. No figure for CO_2 is given for any of the celluloses isolated by their method. Thus it is not possible to say how much, if any, of the uronic anhydrides still remained associated with the celluloses. Even a mild alkali treatment, hot or cold, removes a portion of the hemicelluloses (including polyuronides). The figure for Cross and Bevan's cellulose is generally low, mainly on account of the pre-treatment with 1% boiling NaOH, and partly due to the strong oxidizing action of moist chlorine on cellulose. Boiling with 3% Na_2SO_3 solution (which is *alkaline*) also removes some of the hemicelluloses. This is common to Cross and Bevan's as well as Norman and Jenkins' methods.

The ClO_2 method of Schmidt (in modified form) is better in that it gives a much higher yield of cellulose, most of the hemicelluloses remaining intact. But the oxidizing action of ClO_2 for a prolonged period affects the cellulose to some extent. This is evident from the high loss the cellulose suffers in an alkaline boil as well as from its high copper number. Furthermore, some other constituents besides lignin are removed during the estimation inasmuch as the figures for cellulose and lignin never make 100 but fall short by about 5 in the case of jute.

In view of our incomplete knowledge regarding the mode of association of the hemicelluloses (including polyuronides) with the true cellulose in plant materials, it would appear more rational to regard *all* polysaccharides (*i.e.*, pentosans and hexosans) and polyuronides as jointly comprising 'total cellulose' (and in the case of fibrous materials, 'fibre cellulose') than to include 'cellulosans' alone. Besides fat and wax, traces of mineral and colouring matters, plant materials may then be considered broadly to consist of total cellulose and lignin. The ideal method of estimation of cellulose should aim at the *complete* removal of lignin without affecting the other portion in any way. In such a case, the percentage figures for lignin and total cellulose should make 100 (within limits of experimental error), and, also the cellulose should have a low solubility in alkali and have a small copper number. None of the current methods gives such a result. We have tried all these in the case of jute and examined the cellulose obtained by each method. The polyuronides are removed to a larger extent by Norman and Jenkins' method (as will appear from the CO_2 values in Table II), no doubt, but a fairly large portion (nearly 50%) still remains with the cellulose. From the CO_2 value of raw jute, it is found that jute fibre contains 5·20% of uronic anhydrides. The particular sample (a very good white jute, free from bark and speck) under investigation has 11·80% of lignin and 5·20% uronic anhydrides. The figure for Norman and Jenkins' cellulose (it was *completely* free from lignin) being 77·77%, it would appear that 7·83%, that is, $100-(77{\cdot}77+11{\cdot}80+\frac{5{\cdot}20}{2})$, of the hemicelluloses (other than uronic anhydrides) or 'cellulosans' of Norman and Jenkins have disappeared. So far as jute is concerned, the method seems unsuitable ; some poly-saccharides as well as some polyuronides are lost* though the removal of lignin is complete, differing from most straws and woods examined by the authors. The above calculations are based on the facts that (*i*) uronic anhydrides alone yield CO_2 on boiling with 12% HCl but not

[1] *Biochem. J.*, 27, 818, 1933.

* Presumably during the treatment with 3% boiling sodium sulphite solution which is alkaline.

polysaccharides, (*ii*) the yield of CO_2 is *quantitative* unlike that of furfural (which is derived from uronic anhydrides as well as pentosans), (*iii*) lignin gives only a little CO_2 (about 1·5%) which may be neglected in view of the small p.c. present in jute.

Sodium chlorite has been found to be an excellent reagent for the estimation of cellulose in jute fibre. Previous work in this laboratory has shown that jute can be bleached to full white with $NaClO_2$ under suitable conditions with very small damage to the cellulose. Jute yarn bleached with $NaClO_2$ maintained as much as 70% of the wet strength while that bleached with ClO_2, had practically no strength when tested wet. The lignin content of the bleached yarn was extremely low (1·3%) while the fibrous structure remained intact. This at once suggested that hemicelluloses which are the real binding material for the tiny, ultimate cells of jute, are not removed or materially affected by $NaClO_2$ during the separation of lignin. One could, therefore, employ this reagent for the estimation of total cellulose in jute. This has been done under different conditions and the results obtained are described here.

Preliminary experiments have shown that in presence of fat and wax, jute fibre cannot be bleached fully—a pale yellow colour persists up to the end. Defatted jute (extracted with alcohol-benzene mixture) on the other hand is readily bleached white. So, in all our experiments on delignification, we have used solvent-extracted fibre. By trial, it has also been found that 60°—70°C is the most suitable temperature for the removal of lignin from jute without degrading the cellulose. At boiling water-bath temperature, the reaction is more vigorous ; the yarn is bleached more quickly but it suffers appreciable loss in strength, and degradation of the cellulose probably takes place. $NaClO_2$ liberates ClO_2 rapidly and is quickly spent at 100°C. So this temperature was avoided. At room temperature the reaction is very slow and hence unsuitable for practical purposes. Then again, neutral or alkaline $NaClO_2$ solution is no good for bleaching jute. Slightly acid solution is the most effective. We have found *p*H 4 – 5 to be the most suitable for estimating cellulose. It has further been observed that a weak acid such as acetic acid when used to lower the *p*H of the chlorite solution (our $NaClO_2$ solution was always alkaline—as we prepared it by passing ClO_2 gas into NaOH solution) gives much better results than strong mineral acids *e.g.*, H_2SO_4. So we have always used glacial acetic acid to bring the chlorite solution to the required *p*H. From table I, it would be seen that the strength of sodium chlorite required for complete delignification is fairly high, that is, 3·5% and above. There is nothing objectionable in it provided such treatment does not affect constituents other than lignin. From the analytical data, it will be seen that the cellulose obtained with the fairly high concentration of chlorite is not appreciably degraded. Four hours have been found to be just sufficient for complete separation of lignin from the fibre ; a shorter exposure under otherwise optimum conditions usually leaves some residual lignin in the fibre.

The New Method : 2 gms. of finely cut and defatted fibre were taken in a conical flask (200 c.c.) of the $NaClO_2$ solution of *p*H 4—5 (using acetic acid to lower the *p*H) and known strength were added. The fibres were spread out into the liquid with a glass rod and the whole placed on a water-bath maintained at 60°—70°C for 4 hours, with occasional stirring with a glass rod. An air condenser was placed on the conical flask. After four hours, the contents of the flask were filtered through a Jena glass filter (1G3), thoroughly washed with cold water until free from chlorite (starch-iodide paper moistened with acetic acid turns blue with $NaClO_2$). The fibre was next antichlored with a 3% solution of $NaHSO_3$ and again washed thoroughly. The crucible was dried on a water-bath under reduced pressure (using a water pump and finally, Cenco pump), for when heated at 105° in air, the cellulose turns light yellow. The crucible was kept overnight over H_2SO_4 under vacuum and weighed. The heating was continued until the weight was constant.

The cellulose obtained is milky white in the first four cases (Table I) using 3·5 to 5·2% $NaClO_2$. The residual lignin was estimated in the cellulose by 72% H_2SO_4 method after preliminary boiling for 1 hour with 5% H_2SO_4, following Norman and Jenkins' procedure.[2] In the first four cases the small residue left after the dissolution of cellulose with 72% H_2SO_4 was *not* lignin (for it was not dissolved by ClO_2 solution) but cuticle (scales were visible to the naked eye). For each estimation, duplicate experiments were made. The mean values are given below. Sodium chlorite was estimated by adding excess of KI to the acidified solution, and then titrating with thiosulphate the I_2 liberated.

TABLE I

Expt. No.	% Strength of sodium chlorite	% Fibre cellulose (calculated on dry raw jute)	% Residual lignin (calculated on fibre cellulose)
1	5·2	88·02	0·20
2	4·5	88·93	0·42
3	4·0	89·16	0·38
4	3·5	90·03	0·60
5	3·0	92·90	2·04
6	2·5	93·62	2·50
7	2·0	95·41	4·51

[2] *Biochem. J.*, *28*, 2147, 1934.

The sample of jute used in these experiments has a lignin content of 11·80%.

Cellulose has been prepared by the three current methods, and the new method, from the same sample of jute strictly following the recommended procedures in each case. The celluloses thus obtained have been analysed for their quality in the usual manner. The results are shown in Table II. The distillate from pure glucose or α-cellulose with 12% HCl gave a ppt. with phloroglucinol, in all probability, due to hydroxymethylfurfural from hexoses. This was almost wholly soluble in 95% hot alcohol. So in the estimation of furfural, we have in all cases washed the phloroglucide with 95% hot alcohol.

Mathieson Alkali Works of New York have developed the manufacture of $NaClO_2$ (which they call Textone). It is quite likely that after the war this chemical will be available at a reasonable price for industrial bleaching. So the present laborious method of its preparation in the laboratory will be avoided. Then it will be much easier to estimate cellulose with $NaClO_2$ than now.

Compared with the other existing methods, the new method is far less time-consuming. Furthermore, it requires the least amount of attention. Unlike Cross and Bevan's or the ClO_2 method, it does not involve the application of obnoxious gases which are troublesome to work with. One has to be extremely active throughout the whole working day in giving alternate treatments with sodium hypochlorite and hot sulphite, transferring a good number of times *quantitatively* and so on, in the case of Norman and Jenkins' method. Nothing of the sort is required here. No hot alkaline treatment (with NaOH or Na_2SO_3), before or after, is necessary in this case. We have not tried this method as yet in the case of straw or wood, but so far as bast fibres are concerned, the $NaClO_2$ method for the estimation of cellulose appears to be neat, simple, quick and accurate.*

TABLE II

Method	% Cellulose* (on dry raw jute)	% Lignin (on 'Cellulose')	% CO_3 (on 'Cellulose')	% Furfural (on 'Cellulose')	Copper number (on 'Cellulose')	% α-Cellulose (on 'Cellulose')	% α-Cellulose (calculated on raw jute).	% 'Cellulose' + % Lignin (on raw jute)	% Loss on alkali (2% NaOH) boil (4 hrs.) on 'Cellulose'.
Cross & Bevan's ..	72·55	·02	1·04	8·94	1·03	78·01	56·61	84·35	14·59
Chlorine dioxide ..	84·96	·20	1·67	9·27	4·70	70·88	60·22	96·76	41·01
Norman & Jenkins' ..	77·77	·18	0·86	7·20	2·69	78·65	61·15	89·57	30·35
Sodium chlorite ..	89·03	·40	1·46	9·85	1·48	68·15	60·43	100·83	30·23

* 'Cellulose' refers to fibre-cellulose, that is, α-cellulose together with hemicelluloses.

Copper number was determined by the Schwalbe-Braidy method.

The analytical figures for the sample of jute (J-161) employed are given below for comparison.

J-161 defatted fibre :

(1) Lignin .. 11·80%
(2) Copper number 1·91%
(3) Loss on alkaline boil .. 18·40% (2% NaOH for 4 hrs.)
(4) Furfural .. 9·05% (the phoroglucide was not washed with hot alcohol)
„ .. 8·50% (the phoroglucide was washed with hot alcohol)
(5) CO_2 .. 1·30%

* Our grateful thanks are due to Mr C. R. Nodder, Director, for his kind interest in the work.

MEDICINE AND PUBLIC HEALTH

MALARIA IN BENGAL

THE 25th Annual General Meeting (Silver Jubilee Session) of the Central Co-operative Anti-malaria Society Ltd., and the annual conference of representatives of rural societies in Bengal, was held on the 17th December, 1944, in Calcutta, Mr L. K. Elmhirst, M.A. (Cantab.), B.Sc. (Cornell), Agricultural Adviser to the Government of Bengal, presiding.

In presenting the annual report of the Society for the year ended the 30th June, 1944, the Secretary stated that the Central Society claims the credit of having organised nearly 3000 societies in the villages of Bengal during the last 25 years. These rural societies are purely voluntary organizations and carry on anti-larval measures on approved scientific principles to the best of their power and resources.

The present epidemic of malaria is due to intermixture of the people due to war conditions and not to the only factor of mosquitoes, as supposed.

The Society has found more and more truth in the extensive application of naturalistic method of malaria control such as by the introduction of larvaevorous fish in tanks. The malaria problem of rural Bengal is a question of *tank malaria* mainly due to the presence of innumerable insanitary pools. By inducing and encouraging the people to free their tanks properly of aquatic vegetations, predatory fish, overhanging jungles around their edges etc., in order to get their supply of fries, or spawns of carps, free of charge from the fishery department of Bengal, it was expected the malaria could successfully be controlled in many villages, as these tanks would no longer become hotbeds for the breeding of mosquitoes. By adopting this policy of the fishery department, it might be possible to do away with a large number of mosquito-breeding places in the rural areas.

Mr Elmhirst, in his presidential address, stressed the need for collaboration between Government and the people in eradicating malaria. He suggested that the proper treatment of tanks, *beels*, and rivers in Bengal was essential before malaria could be successfully fought. In the treatment of water he included the scientific cultivation of fish. With more water available, more crops could be grown and better balanced nutrition would result. The building and maintenance of roads must also engage the attention of co-operative workers, for without a good system of communications there could be little improvement in the economic position of villages.

General education and better housing and hygiene, including clearance of slums, rural, urban, and industrial were other vital factors in rooting out disease. "Through the combined operations of scientists, economists and villagers alone can the malaria-carrying mosquito be overcome".

H. E. Mr R. G. Casey, Governor of Bengal in a message to the Central Society said, "By mobilising popular support in the fight against malaria, and by stimulating interest in preventive measures, you are undertaking a task which is in accordance with the highest ideals of Public Service, and I wish you every success in your future efforts".

"I hope the Society will succeed in expanding the sphere of its activities in the mofussil and so help Government in combating the scourge of Bengal malaria."

ROLE OF CAFFEINE IN ULCERS

Gastroenterology, April 1944, contains a paper by J. A. Roth and A. C. Ivy on their recent experimental studies regarding the role of caffeine in ulcers. As pointed by Roth and Ivy, few clinicians restrict the use of coffee in their management of the peptic ulcer patient. The experiments recorded in this paper were devised to determine the effect of caffeine in experimental ulcers in an attempt to obtain prolonged and continuous caffeine action. The technique of embedding caffeine in a beeswax-mineral oil mixture was used. The caffeine mixture was prepared in batches consisting of 22·5 grams of anhydrous caffeine alkaloid, 15 c.c. of melted bleached beeswax, and 60 c.c. of hot mineral oil. The final mixture gives approximately 300 mg. of caffeine base per cubic centimeter. This mixture was injected alternately into the shoulder, thigh, calf and back muscles of a series of 22 cats. Injections were made daily. A control series of 10 cats received an equal quantity of a warmed mixture of mineral oil and beeswax in the same proportions as used in the caffeine preparation. The prolonged administration of the caffeine mixture was found capable of producing gastric ulcers in these animals. The period of time varied from 3 to 38 days, although not all animals developed erosions. These results suggest that the *excessive use* of caffeine-containing beverages may play a controversial role in the pathogenesis of gastro-duodenal ulcers in man. In view of these observations and the marked stimulation of gastric secretion in man by the oral or parenteral administration of caffeine, it is suggested that the use of caffeine beverages may be best restricted in the management of the patient with peptic ulcer.

CONTROL OF MALARIA IN U. S. A.

AN account of the successful control of malaria in the U.S.A. has been given by Major O. R. McCoy, Director of the Tropical Disease Control Division, at a recent meeting of the American Association for the Advancement of Science in Cleveland (*Science News Letter*, September 30, 1944). In 1943, malaria cases in the Army stationed in the Continental United States dropped to a record low figure of only 2 per 10,000. Major McCoy traced the cause primarily to the ten-million-dollar campaign against the mosquito breeding places which has been continued for the last three year. In addition to the customary measures of drainage and oiling heavy use has been made of various larvicides, of which DDT, the new insecticide, has proved most effective against larvae as well as adult mosquitoes. Great success also attended the aerosol 'bomb' method attacking mosquitoes. Major McCoy further expressed his opinion that complete suppression of mosquito breeding would, however, be impossible in the tropics and accordingly reliance must be placed partly on personal defences and on anti-malarial drugs.

RAT CONTROL

GAURCHANDRA GHOSH,
CHARTERED CIVIL ENGINEER

PUBLIC attention has recently been drawn to the subject of rat control by the Bombay Government's offer of half an anna per rat killed. It is estimated that in India nearly one million tons of food grains are destroyed by rats every year. In a given community the rat population is said to be roughly equal to that of its human habitants. In U. S. A. the annual cost of feeding a rat is estimated to be two dollars. The Americans are certainly much better fed than the average Indians, and on that count the standard of food for the American rats may be expected to be much higher than their Indian colleagues. Taking the standard to be, say, one-third for India, the cost of feeding an Indian rat may be taken as two rupees per year. Assuming 388 millions of rats living side by side with 388 millions of India's human population, the annual cost of feeding our rat community amounts to 776 million rupees. Besides this, they destroy materials worth ten times the cost of feeding them. There are instances of rats completely destroying the harvest, which led to food shortage and famine. Control of rats has thus a very great economic significance.

PUBLIC HEALTH IMPORTANCE

Control of rats is also an important public health problem. Rats are responsible for the transmission of plague, a very dangerous disease. Besides plague, rats spread directly or indirectly many other diseases. Rat-bite-fever, though a very rare infection, is said to be due to bites of rats. Rats are responsible for infectious jaundice caused by a spirochete infection. The spirochetes are excreted in the urine of infected rats, and thereby food, water and soil may become contaminated. Human infection takes place either through skin or mouth. *Trichinosis* is quite common among rats which get infected by eating each other or infected pork. Swine get infected by eating infected rats and offal, and men get infected almost exclusively by eating pork or boar meat not thoroughly cooked. Rats and mice are carriers of *B. enteritides*, and they also transmit certain types of tape worms and parasites which concern man.

RATS AND THEIR HABITS

Distinction between rats and mice are largely based on size. The following are the common types :—

(1) The common house mouse (*Mus musculus musculus*).
(2) The black rat (*Rattus rattus rattus*).
(3) The Egyptian or roof rat (*Rattus rattus alexandrinus*).
(4) The brown rat, also variously known as grey rat, barn rat, wharf rat, sewer rat, and Norway rat (*Rattus norvegicus*).

Rats live on an average for two years. They are prolific breeders and on an average produce annually five litters of six to nine rats each time, sometimes as much as twenty-two at a time. Starting with one pair of rats and assuming no casualties, it may be possible to have as many as two crores of rats in three years. The black and roof rats are expert climbers and jumpers. They do not burrow, but live in hollow spaces and roofs, or nest in trees. Empty metal can two feet deep is not sufficient to retain the black rat. Both black and roof rats are rather clean in their habits and prefer grain and clean, fresh food. Brown rats are not good climbers, but are provided with good gnawing mechanism and generally make

burrows 1½ to 1 feet deep (some-times two feet or even more) where they live. They can gnaw holes in lead pipes, slate, wooden beams to a depth of two or three inches. They are good swimmers and can remain in water for a long time. They eat just anything, fresh or rotten.

Rats are also migratory in their habits and often leave dwellings for barns and fields and after a period again return to their usual abodes.

Control of Rats

There are two types of control, (*a*) destruction, and (*b*) suppression.

(*a*) *Destruction of rats.*—Various measures may be adopted, such as trapping, fumigating, poisoning, starving or annoying.

Extermination of rats is, however, a biological impossibility. To be effective, these measures must be continued and constantly watched. When conditions become intolerable for them the rats usually leave the area but soon return if the control measures are stopped. There are various types of traps that are used. It is difficult to catch black rats in cage traps ; the more effective types against them being snap traps and dead falls. The quality of the food offered in the trap does not matter much. The most important point to ensure is that the food offered in the bait is the only food easily accessible to the rats.

Fumigation is effective in enclosed spaces and is widely used for destruction of rats in ships and ware houses, hydrocyanic acid gas being generally used for the purpose. As the gas is lethal to human beings it should be used only by experts. Various types of poison baits made from yellow phosphorus, arsenic, strychnine, and most commonly barium carbonate, are used. Their efficacy in the control of rats is debatable. These poison baits are also dangerous to human beings and should be used with caution.

Starving out the rats by separating them from their usual food supply is a very effective method, as rats require a large amount of food for their existence. All food stuff should be kept inaccessible to rats, and garbage should be kept in rat proof containers.

Employment of cats and other animals who feed on rats does not generally prove to be effective.

(*b*) *Suppression and Control.*—In buildings and structures, rats live in enclosed and hollow spaces, under floors, inside pipes, holes in walls, in various types of furniture and fixtures, in heaps of trash, old discarded equipments, boxes and similar materials. For preventing rats from invading buildings and structures they should be designed in such a manner as to eliminate unnecessary enclosed spaces and where this is impossible we must use materials impervious to rat gnawing and install them in a rat proof manner. To achieve this objective several engineering principles must be observed. Foundation walls should be built of rat-proof material, plastered to a smooth surface and should extend at least 3 ft. below ground level. Walls and floors should be of solid construction without intervening spaces. Double walls should be avoided as far as possible. All openings around pipe lines passing through wooden floors or ceilings should be fitted with metal rat proof collars, and openings through walls for pipes and beams should be fitted in with cement or concrete. Openings in ventilators, space over wall plate roof rafters etc. should be fitted with sheet metal having perforations not exceeding ½ inch in diameter or width, these being better than wire mesh or expanded metal. In case of rectangular, horizontal or vertical openings, as in louvers or between sliding doors and building walls, the maximum width of opening should not exceed 3/8th inches to prevent rat ingress. If floors are made of wood or other non-rat-proof material, they should extend to rat proof base-board and the protective rat-proof material, like sheet metal, must extend to the side walls and be fitted thereto.

Furniture and equipments in houses, if badly designed, may harbour rats. Show window display counters should have walls of rat proof material. Store counters, wall cabinets, filing cabinets, desks etc. should be either of the elevated type in which there is an intervening space of 10 to 12 inches between floor surface and undersurface of bottom drawers etc., or they should rest flat on floor and against walls without any enclosed spaces. Metal flashings should be installed along the lower edges of the fixtures to prevent gnawing by rats. Storage bins should preferably be of metal sheets and should be either elevated about 12 inches from floor or should rest flat on floor so as to avoid any enclosed spaces. Refrigerators should preferably be constructed of metal and should be installed on such a manner as to avoid any enclosed spaces at the bottom or sides between floors and walls. Ventilating ducts and air conditioning trunk lines should be constructed of approved rat proof material, preferably hard sheet metal, and they should be installed in a manner which will eliminate flat surfaces on the top which can be utilized for rat harborage.

By applying the above principles, defects in existing buildings and structures can also be rectified. Walls and floors should be repaired, and all interstices, crevices, and holes should be filled up with cement and plastered to a smooth surface. All enclosed spaces between walls, floors and other fixtures should be eliminated, failing which they should be closed with rat proof metal flashing.

Grain stores should be properly designed to prevent ingress of rats. The foundation walls should be

extended at least 3 feet below ground level. Floor should be of solid construction, such as concrete. At a height of 3 feet above the ground level there should be a projecting ledge all round, 9" wide to prevent entry of rats from outside. Steps should be avoided. The openings and ventilators should be fitted with sheet metal screen with perforated holes not more than ½ inch in diameter.

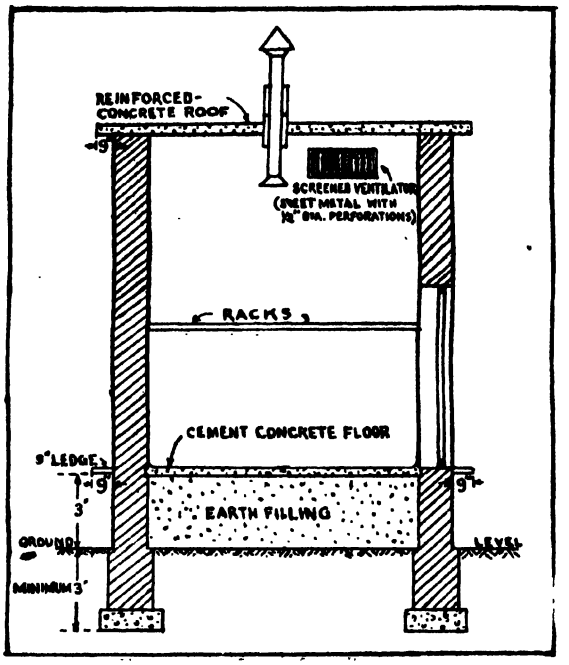


FIG. 1. Rat proof store (with top ventilation)

To ensure control of rats in buildings and structures, there should be rat proofing ordinances for all cities. These ordinances should require buildings to be constructed in a rat proof manner. Plans must first be approved before actual construction may be allowed to be undertaken. The local health authorities should be empowered to make rules for enforcing these ordinances and to inspect buildings during and after construction. The health authorities should lay down rat proof designs and fundamental approved methods of construction for the guidance of the public.

The problem of rat control in rural areas in India is difficult owing to the use of non-rat proof materials such as mud, bamboo, wood, straw etc., for house construction. The problem is important both from the public health and from the economic point of view. For devising effective measures of control, the public health workers must closely co-operate with the engineers.

BOOK REVIEWS

The Loom of Language—a guide to foreign languages for the home student—by Frederick Bodmer, edited and arranged by Lancelot Hogben; Pp. 669; George Allen & Unwin Ltd., London, 1943. Price 15 Shillings.

The editor says in his preface: "because this book is a successor to *Mathematics for the Million* and *Science for the Citizen*, its motif is social and its bias is practical." Now language—as distinct from mere word-sounds—being a purely social phenomenon the motif of a book like this cannot but be social; but there is ample reason to doubt whether there is anything substantial in the book to justify its claim for the bias for the practical. Is it "practical" to tell a man who wants to learn Russian to take the precaution of being born and brought up in Russia (p. 415)? Is it practical to burden the book with obscure and ill-defined rules of Teutonic and Roman languages? I doubt if any practical man to-day will devote any time to Swedish, Danish, Dutch, Spanish and Portuguese—to which our author has given so much of the space at his disposal.

From the consideration of the science of language and also from the practical point of view, the book will appear hardly impressive. Yet the noble purpose with which the book has been written cannot be admired enough. The author rightly says that international peace and understanding cannot come without an international vehicle of ideas. And with a view to that end he has here—without trying to figure out in all its details such a vehicle—attempted heroically to beat down the linguistic barriers separating even in this fast contracting world country from country and nation from nation.

B. K. G.

The Aborigines—"So called"—and their future.—By G. S. Ghurye, Ph.D. (Cantab.) Professor and Head of the Department of Sociology, Bombay University Publication No .11 of the Gokhale Institute of Politics and Economics, Poona, Pp. XVI+232. Price Rs. 8/-.

In a country like India, with a vast primitive population, estimated to be well over twenty millions,

and by some put even higher, the question of acculturation is bound to loom large in any plan of national welfare. The surprising fact remains that even now only a very limited number of persons—mostly anthropologists (including sociologists) and administrators, have taken any interest in the matter. Dr Ghurye has performed a useful service in collecting together a large mass of relevant information regarding the subject in the work under review.

Dr Ghurye has limited his survey mainly to the tribes of the great Central Indian plateau or as an earlier writer puts it, of the Western and Central belt of primitive people in India. Such a limit has presumably been observed as this group has been in more intimate contact with Hindu India than is, for example, the case with Assam tribes.

In the earlier chapters Dr Ghurye considers the distribution of the tribal folk and the effects of the contact with Hindus on them. The good effects of such contact, in the way of spread of more advanced methods of food growing and materials, arts in general as well as the evil effects that have followed through the rapacity of money lenders and land grabbers, are noted. Dr Ghurye seems to think that the balance of good over harm is favourable in most cases. In drawing such a conclusion Dr Ghurye has relied entirely on the work of others, in the absence of personal experience. He has quoted in this connection administrators and anthropologists who have been in fairly intimate touch with the primitive people.

In the later chapters Dr Ghurye has summarised the various administrative measures and legislative action taken by the Government of India and the British Parliament regarding the "so called" aborigines. In this connection he has brought out clearly the contradictions involved in the policy of an imperial power in their contact with backward people. Dr Ghurye quotes the forest reservation policy as an example of a measure which has injured tribes like the Korwa and the Birhor. If Dr Ghurye had had first hand acquaintance with the tribes of the Central Indian Plateau, he would have found that there has been a constant clash between measures designed to safeguard or increase revenue, and measures intended to protect the primitive tribes. More often than not, the interests of the revenue department have prevailed.

Dr Ghurye next discusses the views of anthropologists like Rai Bahadur S. C. Roy, Dr Elwin, and Mr Grigson regarding the problem of culture contact and culture assimilation. Dr Ghurye has rightly criticised what may be termed the romantic view of tribal culture. Primitive people are considered by some administrators and anthropologists to be like children and they recommend that the tribal people should be treated as such and separated from the rest of the Indian population, and allowed to express themselves through their primitive full blooded tribal culture. The mistake of the up holders of this view is that they ignore that (*a*) the tribal culture has large elements borrowed from the Hindu culture, which in its turn has assimilated many traits of the primitive culture and (*b*) a culture which does not change with the alterations in its cultural environment will assuredly perish. Any period of transition is bound to cause hardships to those who stick to the old ways. This fact should not however lead the sociologists to speak against social change. On the contrary, it should be their duty to indicate the best way to accomplish the transformation with the minimum amount of travail.

It would be a mistake at the same time to ignore the immense amount of harm done by persons of advanced culture who seek out the primitive folk only with the intention of making a profit out of them. The injury such a person inflicts in the process is of the same type, on a miniature scale, as that brought on colonial people by imperial rulers in the course of their economic exploitation. Any benefit that may accrue, incidentally, such as the spread of more advanced methods of material culture, does not justify the harmful effects, in either case, and cannot lead any scientific student of culture to approve of the continuation of such modes of contact, whether on an imperial scale or in the domain of culture contact of advanced people with primitive folk.

Dr Ghurye argues that the economic problem of our peasantry and artisans are comparable to that of the aborigines. He notes that "the problem regarding land . . . is very largely the same for a large section of our population whether aboriginal or non-aboriginal". All this is quite correct in a general way. But he offers no solution which will help to save both sections of the people, while taking due note of the differences in their cultural condition. Dr Ghurye's view seems to be that general measures of protection such as the Money Lenders' Acts, or Tenancy Acts passed in the different provinces will be adequate. Dr Ghurye has fallen into the opposite error to that of the romantic school and has overlooked the fact there are definite and valuable elements in the social and mental make up of the aboriginal, which are likely to be destroyed by lack of protection. A Santal, for example, is essentially freedom loving and has a sense of self-respect, which makes him feel himself the equal of any other man. In his social and economic life again, a Santal places the interest of the village above that of the individual. It would be a tragedy if he became just a caste man in Hindu society or a subservient unit, among the followers of any other creed. It would also be a great pity if he ceased to care for the village and pursued his calling, impelled mainly by the profit motive. Dr Ghurye's apprehension seems to be that

protection would make tribal man a hostile misfit in the future Indian population. There is no doubt that the activities of missionaries interested mainly in evangelisation and of politically minded administrators has done this harm to some extent. The remedy is however not the opposite evil of absorption into Hindu or any other advanced society.

Our duty, as sociologists and well wishers of all sections of our countrymen, should be to place the best that world knowledge has to offer, at the service of all ; to approach the humbler and the backward, without any motive of profit or of inflicting our tutelage, neither to look at them with patronage nor admire them through romantically coloured glasses, but to treat them as normal human beings who are entitled to live according to their own ways of life. We should remember that economically they need safeguards—much more than what they are getting now. Culturally they should receive education in the scientific outlook and scientific methods and then left free to develop their own culture not in isolation but in touch with modern conditions.

K. P. C.

Your Food —By M. R. Masani (Tata studies in current affairs). Published for Tata Sons Limited by Padma Publications Ltd., Bombay. Pp. 82. Price Re. 1/-.

"Your Food" is the first of the series of 'Tata studies in current affairs' and deals with the pressing problem of food and nutrition in India. It is meant to educate and stimulate public interest in this vital problem of India, which in course of time may influence policy and action.

The author belongs to the Public Relations Department of Tatas and among his varied qualifications is the fact that he is the Chairman of People's Provincial Food Council, Bombay. The book is written with the idea to appeal to a very wide circle of readers rather than to a select few and Sir Homi Mody in his foreward to the book rightly observes that the subject matter has been treated in a "popular" 'more in the nature of a fireside chat than an elaborate treatise on the subject'.

A new feature of the book is that it is suitably illustrated on modern lines, that makes it highly intelligible. The writer has discussed the problems arising out of the shortage of food production in India, and suggested ways and means for increasing the production to cope with the growing population of India. Useful data is to be found with regard to a 'balanced diet' and in the author's opinion it is poverty and not ignorance or habit that is the main factor why the diet of our people is not properly balanced and deficient in nutrient elements. A domestic diet survey according to income carried out at Jamshedpur among the employees of the Tata Iron and Steel Works, illustrate that the quality and quantity of food improves as the income rises. It is depressing to note that well-balanced diet is beyond the means of the majority of our people. A rise in the income of our people, whether from agriculture, industry or trade would in itself ensure a better food. Food problem is thus bound up with the problem for the abolition of poverty.

If the book is found to have a wide appeal, it is intended to have translation in some of the leading Indian languages. Tatas will further endeavour to respond to requests for free copies from rural development centres and educational and other institutions which would not otherwise be able to obtain them.

A. K. G.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

ON THE AVERAGE LIFE OF THE PLATINOCYANIDES IN SOLUTION

VERY recently we have investigated in detail the polarisation of the fluorescent radiation emitted by the different platinocyanide compounds in solution at different temperatures and concentrations under the excitation by light of various wavelengths. We have also calculated the average life of the excited molecules from the aforesaid polarisation measurements, the results of our calculations being given here.

TABLE I

AVERAGE LIFE OF THE PLATINOCYANIDES EXCITED BY λ 3131 A AT DIFFERENT VISCOSITIES

Viscosity of the solution	Sodium platinocyanide Conc. = 5×10^{-1} gm/cc.	Potassium platinocyanide Conc. = 5×10^{-1} gm/cc.	Barium platinocyanide Conc. = $\cdot 5 \times 10^{-1}$ gm/cc.
4·56	—	—	$1 \cdot 80 \times 10^{-9}$ sec.
1·65	$1 \cdot 20 \times 10^{-9}$ sec.	$1 \cdot 24 \times 10^{-9}$ sec.	$1 \cdot 91 \times 10^{-9}$,,
61	$1 \cdot 51 \times 10^{-9}$,,	$1 \cdot 24 \times 10^{-9}$,,	—

TABLE II

AVERAGE LIFE OF THE PLATINOCYANIDES EXCITED BY λ 3131 A AT DIFFERENT TEMPERATURES

Temperature in °C.	Sodium platinocyanide Conc. = 5×10^{-5} gm/cc.	Barium platinocyanide Conc. = $\cdot 5 \times 10^{-5}$ gm/cc.	Potassium platinocyanide Conc. = 5×10^{-6} gm/cc.
28	—	$1 \cdot 8 \times 10^{-9}$ sec.	—
40	$1 \cdot 3 \times 10^{-9}$ sec.	$1 \cdot 75 \times 10^{-9}$,,	$1 \cdot 4 \times 10^{-9}$ sec
50	$1 \cdot 4 \times 10^{-9}$,,	—	$1 \cdot 35 \times 10^{-9}$,,

Thus it shows that within the limits of the experimental error the value of the average life is independent of the temperature and viscosity of the solution; but depends on the concentration of the fluorescent compounds in solution. We have also calculated the average life of the compounds when excited by lights of various wave lengths. In the case of excitation of sodium-platinocyanide by λ3131 the life was observed to be $1 \cdot 3 \times 10^{-9}$ sec.; whereas, for λ2537 excitation it was $1 \cdot 32 \times 10^{-9}$ sec. This shows that the life is also independent of the exciting wave length.

Further, it was observed that all the three platinocyanides have the same average life, which was of the order of 10^{-9} sec. In the case of the solid platinocyanides, which are intensely luminescent the average life was of the order of 10^{-5} sec. as measured directly. This difference is rather remarkable as the $Pt(CN_4)$ complex is obviously responsible for both the processes.

S. M. MITRA
A. K. M. SIDDIQ

Physics Laboratory,
Dacca University,
Dacca, 8-11-1944.

ON THE EXTRA REFLECTIONS IN THE LAUE PHOTOGRAPHS OF PHLOROGLUCINE DIHYDRATE CRYSTALS

I

IN a recent note Dr S. C. Sirkar[1] has drawn attention to a point about the highly interesting results obtained by C. R. Bose[2] in his investigations on the secondary extra reflections from phloroglucine dihydrate crystal. The point is whether these reflections are of the same nature as the secondary extra reflections from diamond. The apparent dissimilarity pointed out by Dr Sirkar will easily disappear if one considers the result from the standpoint of the reciprocal lattice. In the case of phloroglucine dihydrate the break-up of the lattice is along the c* axis. The direction of the reflected beam as determined by the intersection of the sphere of reflection with the linear extensions of the reciprocal lattice points along c* direction will easily be seen to be affected very slowly when the crystal is rotated from the position where the X-ray beam is incident along the c-axis and the Bragg angle is not large. In the setting of Lonsdale and Jahn,[3] it will be seen similarly from considerations of the reciprocal lattice that the variations will be much greater.

The simple explanation of this effect suggested by Dr Sirkar cannot unfortunately explain the observed facts. It is a well-known fact that the type of misorientation postulated by him would give rise to arcs which in the ideal dis-orientation of the powder photograph would become circles. However, it is possible to think of such preferred disorientation that would give rise to a sharp reflection even for a large deviation from Bragg angle, but it is impossible to explain all the sharp spots on the phloroglucine dihydrate photograph by any such postulate of preferred orientation. In fact the only conclusion that can be obtained from the positions of the spots on the photographs is that mentioned in a paper by Bose and the present author[4] that the lattice is broken up along the c-axis while retaining regularity along the a and the b axes so as to simulate a two dimensional grating. A structure based on extremely thin but extended mosaic blocks also cannot explain the observed absence of this type of extra spots on the equatorial or the meridial lines.

As regards the explanation of the secondary extra reflections in diamond as due to internal strain apart from other difficulties it is untenable for the simple reason of the high magnitude of strain that has to be postulated to explain the observed large deviations from the Bragg angle, upto which the secondary reflections have been observed.[5]

K. BANERJEE

Indian Association for the Cultivation of Science,
210, Bowbazar Street,
Calcutta, 9-11-1944.

[1] Sirkar, S. C., SCIENCE AND CULTURE, *10*, 215, 1944.
[2] Bose, C. R., *Proc. Nat. Inst. Sci.*, *10*, 201, 1944.
[3] Jahn, H. A., and Lonsdale, K., *Nature*, *147*, 88, 1941.
[4] Banerjee, K. and Bose, C. R., *Nature*, *153*, 28, 1944.
[5] Lonsdale, K., *Proc. Roy. Soc.*, *179A*, 315, 1942.

II

The arguments on which the explanation regarding the origin of the extra spots in the Laue photographs of phloroglucine dihydrate offered by me[1]

has been based consist mainly of two points, *e.g.*, (1) that the spots do not move appreciably while the crystal is rotated through large angles and (2) that probably these spots occur in the directions making angles $2\theta\beta$ with the incident beam. Prof. Banerjee's argument regarding the first point is not convincing, because according to his argument the spots ought to *move slowly* with the rotation of the crystal, but actually it has been observed by Bose[2] that they *do not move appreciably* even when the crystal is rotated through large angles. As regards the second point, Prof. Banerjee has not stated anywhere whether the directions of extra spots make angles $2\theta\beta$ with the incident beam or not. The explanation offered by me will be proved to be wrong only if the extra spots are observed to occur in directions other than those mentioned above. But if they are actually observed to occur in those directions the correctness of the explanation can never be challenged. Hence a definite staement regarding this point from Prof. Banerjee would clarify the matter.

S. C. SIRKAR

Physics Department,
92, Upper Circular Road,
Calcutta, 22-11-1944.

[1] Sirkar, S. C., SCIENCE AND CULTURE, *10*, 215, 1944.
[2] Bose, C. R., *Proc. Nat. Inst. Sc.*, *10*, 201, 1944.

III

Dr Sirkar bases his theory upon the single qualitative visual observation mentioned in the paper by Bose[1] that the positions of these spots do not alter appreciably and overlooks the results of the accurate quantitative measurements mentioned by Banerjee and Bose[2] that the positions of the spots accurately obeyed two of the Laue equations *viz.*,

$$a_o(\alpha_o-\alpha)=h\lambda \text{ and } b_o(\beta_o-\beta)=k\lambda$$

The deviations from the fixed positions as given by these equations, though small have been actually verified from the accurate measurements. Hence the second point of Dr Sirkar also does not arise for if the angle is not strictly constant it cannot be equal to $2\theta_B$ for all angles of incidence.

K. BANERJEE

Indian Association for the Cultivation of Science,
210, Bowbazar Street,
Calcutta, 7-1-1944.

[1] Bose, C. R., *Proc. Nat. Inst. Sci.*, *10*, 201, 1944.
[2] Banerjee, K. and Bose, C. R., *Nature*, *153*, 28, 1944.

COLOUR OF SOME NITRO COMPOUNDS

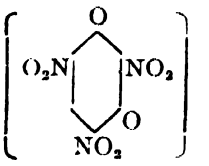
STYPHNIC acid is described in the literature as a yellow compound. On the contrary, we have found that:—

(*i*) Styphnic acid, when crystallised from hot kerosene, is almost colourless, although it subsequently becomes yellow by picking up moisture. It could also be crystallised from other non-aqueous solvents like petrol-ether or CCl_4 in a colourless state, the solubility in these solvents, however, is very limited.

(*ii*) Aqueous solution of styphnic acid, which is yellow, becomes colourless when strongly acidified with concentrated HCl.

(*iii*) The colourless crystals become yellow on melting.

The results indicate that pure, dry styphnic acid is colourless and that the yellow colour it normally exhibits is due to the dissociated anion:



The above observations raise the question of colour, in general, of nitrobodies which are assumed to be yellow inherently.

Picric acid and tetranitroresorcinol, which are closely allied to styphnic acid, are known to exhibit a colour behaviour now observed with styphnic acid; in other words, they are yellow only as the result of picking up moisture.

Trinitromethane or nitroform $CH(NO_2)_3$ is known to form colourless crystals, but turns yellow in water.

It has been possible to crystallise T.N.T. from water in an absolutely colourless condition, and also from CCl_4. This colourless compound, however, slowly turns brown under the influence of light. It is, therefore, reasonable to assume that the slight yellow colour commonly associated with T.N.T. is an induced effect, and that inherently this compound is colourless.

Nitroso compounds are usually colourless, crystalline bodies in the solid state when they exist as dimers; these dissociate by heat or solution into the intensely blue monomolecule. This behaviour is exhibited by many complex nitroso bodies; tertiary-nitrosoisobutane $(CH_3)_3.C.NO$, for example, forms colourless (dimolecular) crystals, but melts to a blue (monomolecular) liquid.

The authors are grateful to Dr H. R. Ambler, Ph.D., F.I.C., Chief Inspector of Military Explo-

sives for helpful suggestions and to the Director of Armaments in India for permission to publish the note.

B. N. MITRA
M. SRINIVASAN

Inspectorate of Military Explosives,
Kirkee, 15-11-1944.

PURIFICATION OF AMMONIUM SULPHATE FROM PYRIDINE

AMMONIUM sulphate of coal tar origin is invariably contaminated with a considerable amount of pyridine. Pyridine would, therefore, persist as an impurity in the ammonia liberated from such ammonium sulphate, and would act deleteriously on the catalyst in the manufacture of nitric acid. Further, this base would appear as an impurity in the ammonium nitrate finally manufactured, which is required to be pyridine-free for ordnance use. It is, therefore, incumbent to ensure that the stock of ammonium sulphate for generating ammonia to be converted to nitric acid should not contain pyridine. In normal practice an oil scrubber is used for affecting the removal of pyridine from ammonia.

An alternative method has been worked out on a laboratory scale as would enable the elimination of traces of pyridine from ammonium sulphate by a preliminary treatment of the material with relatively small quantities of lime. The method is simple in that it does away with the oil scrubber, the use of which entails the installation of additional equipment for washing and recovery of the oil.

100 gm. ammonium sulphate were dissolved in 200 c.c. water in a beaker. Depending upon the pyridine content and the acidity of the material, milk of lime equivalent to 0·25 to 0·5% CaO on the weight of ammonium sulphate was prepared ; the higher the pyridine content, the greater the quantity of the milk of lime required. One-fourth of the milk of lime was added to the ammonium sulphate solution in the cold, air blown in and the mixture maintained at about 90°C. with agitation. At 10-15 mins. intervals, small additions of lime were made, so as to maintain the alkalinity between *p*H 7-8 (*i.e.* between methyl red and phenolphthalein). Under these conditions pyridine was removed with the loss of negligible quantities of ammonia. With *p*H higher than 8, however, the elimination of pyridine was found to be rapid, though with some loss of ammonia.

By this method it is possible to reduce the pyridine content to about ·001% and it takes one to two hours to complete the elimination of pyridine from the ammonium sulphate before it can be used for the generation of ammonia.

Our thanks are due to Dr H. R. Ambler, Ph.D., F.I.C., Chief Inspector of Military Explosives, for his kind interest in the investigation, and to the Director of Armaments in India for permission to publish the note.

B. N. MITRA
W. D. PATWARDHAN
G. SIVARAMAKRISHNAN

Inspectorate of Military Explosives,
Kirkee, 15-11-1944.

A FURTHER INSTANCE OF THE POSTERIOR CARDINAL VEIN IN *BUFO MELANOSTICTUS* SCHNEIDER

POSTERIOR cardinal veins may normally be present or absent in Salientia ; they are generally absent in the two well-known families Bufonidæ and Ranidæ.[5] Records of persistence of these vessels are too numerous in *Rana temporaria*,[5,6] but those in other Salientian genera are only a few, *viz.*, two cases in each of *Bufo*[2,1] and *Limnodynastes*[5], and once in *Xenopus*[5] and *Bombina*[5] (=*Bombinator*). In 1929, the present author recorded a case of persistence of the left posterior cardinal vein, attended with some other minor venous abnormalities, in *Bufo melanostictus*.[2] Since then, the only other report from this genus, so far as I am aware, is Al-Hussaini's record of the persistence of the left posterior cardinal in *B. regularis*.[1]

The present case turned up in course of my dissection of some two hundred toads for studying numerical variations in the dorsol-lumbar veins (in preparation) of which a preliminary note has already been published.[4] It was a fairly full-grown female toad, measuring 82·0 mm. from snout to vent, and was, as far as could be ascertained, normal in other respects.

Observations.—The postcava is entirely absent save in its inter-renal portion, and is functionally replaced by the left posterior cardinal vein which is situated in front of the left kidney. The inter-renal vein is represented by a short vessel and situated mainly over the left kidney. It is formed by the union of two main revehent veins from the kidneys, the right one running superficially and receiving in its course anteriad well-marked factors from the kidney, ovaries, fat-bodies etc., while the left one proceeding embedded on the ventral face of the left kidney and much obscured by the deposit of suprarenal tissue except in its anterior portion. The inter-renal vein after receiving a separate small revehent factor from the cephalic end of

the left kidney, continues on to the left and becomes the posterior cardinal. The posterior cardinal pursues craniad lying by the outer side of the left systemic arch and the vertebral column, and tilting gradually to the left, it courses further forward dorsal to the subclavian artery and the brachial plexus. It then turns ventro-mesiad at its anterior end, and after separately receiving the subscapular and the internal jugular veins, it takes part in the formation of the left precaval exactly at the place where the innominate vein would have joined. It is a fairly stout and prominent vessel of almost uniform calibre and

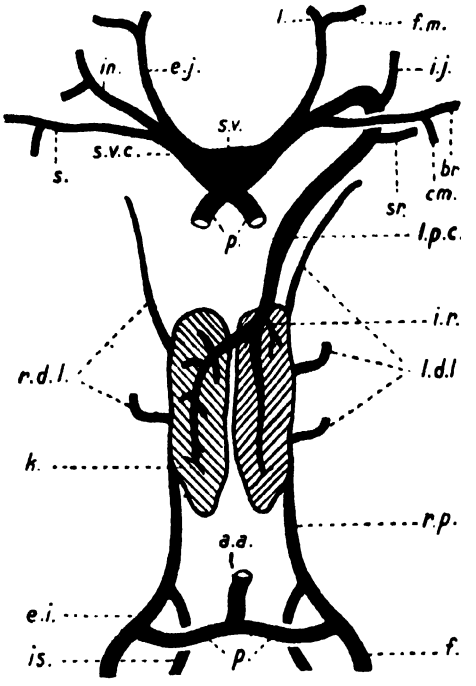


FIG. 1. Diagrammatic representation of the principal veins viewed from the ventral side with heart removed to expose the sinus venosus in *Bufo melanostictus*.

a.a.—anterior abdominal vein ; *br.*—brachial vein; *cm.*—musculo-cutaneous vein ; *e.i.*—external iliac vein ; *e.j.*—external jugular vein; *f.*—femoral vein ; *f.m.*—facio-mandibular vein; *h.*—hepatic vein; *i.j.*—internal jugular vein; *in.*—innominate vein; *i.r.*—inter-renal vein; *i.s.*—ischiadic vein; *k.*—kidney; *l.*—lingual vein; *l.d.l.*—left dorso-lumbar veins; *l.p.c.*—left posterior cardinal vein; *p.*—pelvic vein; *r.d.l.*—right dorso-lumbar veins; *r.p.*—renal-portal vein; *s.*—subclavian vein; *sr.*—subscapular vein; *s.v.*—sinus venosus; *s.v.c.*—*superior vena cava* (precaval).

shows no dilatation anywhere in its course as observed in some frogs.[5] The subclavian vein, however, does not open opposite to the external jugular, as is usually the case, but instead, it opens a little apart directly into the cardinal vein. The right precaval system is normally constituted.[3]

The two hepatic veins open directly into the hinder end of the sinus venosus.

The renal-portal vein (*v. iliaca communis* and *v. Jacobsonii*) is constituted in the ordinary ranid manner[4] and the kidneys are almost equal in size. Each renal-portal enters the corresponding kidney by means of the venæ renales advehentes in the usual manner without establishing a direct connection with any portion of the inter-renal or the posterior cardinal. It is to be noted that there are three dorso-lumbars opening into the left renal-portal (*v. Jacobsonii*) as opposed to two on the right side.[4] Attention may here be drawn especially to the disposition of the anteriormost dorso-lumbar of the left side which runs parallel with the posterior cardinal (*cf.* O'Donoghue, 1931, Exs. 28, 34 and 35). With the arrangements of the veins in the kidneys it can safely be observed that both are portal.

It is well known that instances of the persistence of posterior cardinal vein are readily explained in the light of the developmental history of the postcava in the Amphibia. This has been elaborately dealt with by O'Donoghue.[5] A passing mention may, however, be made that the present case appears to be a bit more primitive in that the inter-renal portion is not fully formed as in normal frogs and toads.

JNANENDRA LAL BHADURI

Department of Zoology,
University of Calcutta,
Calcutta, 24-11-1944.

[1] Al-Hussaini, A. H., *Anat. Anz.*, *88*, 416-420, 1939.
[2] Bhaduri, J. L., *Proc. Zool. Soc. London*, Pt. 2 : 177-180, 1929.
[3] Bhaduri, J. L., *J. & P. Asiat. Soc. Bengal*, (N. S.). *27*, 101-110, 1931.
[4] Bhaduri, J. L., and K. C. Ghose, *J. Roy. Asiat. Soc. Bengal (Sci.)*, *9*, 55-62, 1943.
[5] O'Donoghue, C. H., *Trans. Roy. Soc. Edinburgh*, *57*, 179-224, 1931.
[6] ———, *J. Anat. London*, *70*, 159-176, 1935.

ATMOSPHERIC AMMONIA AS A SOURCE OF NITROGEN FOR SOILS

IN a recent contribution Abhiswar Sen[1] had adduced some evidence to show that ammonia in the atmosphere is a useful source of nitrogen and should, by itself, be capable of accounting for the maintenance of level of fertility—though rather low—of unmanured Indian soils. This concept, though highly fascinating, would require rather critical examination in the light of the various known facts.

There is no doubt that there is some ammonia in the atmosphere. How does it arise? There is no known mechanism by which the atmosphere can produce ammonia. On the contrary, a good deal of

ammonia is released from the soil, the sewers, manures, industrial wastes and so forth. Added to this, there is ammonia given off during the manufacture of coal gas, burning of coal under certain conditions and so forth. These evolutions would account for practically for whole of ammonia present in the atmosphere of large cities like London, Glasgow and Manchester which the author has referred to.

As for the soil itself, it is more capable of giving out ammonia than of receiving it. When the soil has a reaction of *p*H 7·0 and above, it invariably gives off small quantities of ammonia. Application of chalk or burnt lime hastens this evolution. Ammoniacal fertilizers applied to such soils tend to decompose and to steadily give off ammonia, though in small quantities at a time. This is a well known phenomenon and it is partly with a view to minimising this loss that ammonium salts have to be applied as top dressings to crops. All organic manures lose some ammonia during storage and further quantities are lost during their decomposition in the soil, whether it is under dry or wet cultivation.

The Indian Institute of Science has long been interested in the subject of loss of nitrogen from the soil.[2-5] The evidence so far accumulated would show that a large part of nitrogen lost from dry as well as wet soils, as also from manures, is in the form of ammonia. The retention of ammonia beyond a point is difficult and, in fact, the agriculturist is hard put to keeping it in the soil.

A very simple demonstration of the evolution of ammonia from the manure heap would be to hold a piece of moistened red litmus paper over it on a moderately warm day. The litmus will turn blue in less than a minute. Similarly, evolution of ammonia from soils can be demonstrated by placing the soil properly moistened in a petri dish and sticking a piece of red litmus paper to the bottom side of the cover. In the case of some of the Punjab, U. P. and Central Indian soils, the evolution is pretty rapid and especially after the addition of ammoniacal fertiliser, the change in the colour of the indicator can be observed in less than a minute. The evolution is continuous and can be quantitatively estimated.

There is no doubt that the atmosphere contains some ammonia, but it would be seen from the above that a useful part of it comes from the soil itself. The soil has the capacity for retaining some ammonia, but it also gives off a good deal of it so much so that both the processes have to be taken into account. From our experience, we may state that the net result will be found to be one of loss rather than one of gain to the soil.

The author refers to sea water as a possible source of ammonia. He has no proof to show that the land gains by it in the form of rain. The rain water, if carefully collected, is usually free from ammonia.

Taken on the whole, there is a strong need for reinvestigating the whole problem of nitrogen recuperation of soils. The subject is one of much scientific as well as practical interest and it is hoped that it will be possible for the Imperial Council of Agricultural Research to initiate some systematic work on the subject.

V. SUBRAHMANYAN
S. C. PILLAI

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 24-11-1944.

[1] Sen, A., SCIENCE AND CULTURE, *10*, 191, 1944.
[2] Sreenivasan, A. and Subrahmanyan, V., *Jour. Agri. Sci.*, *25*, 6, 1935.
[3] Subrahmanyan, V., *Nature*, *139*, 884, 1937.
[4] Sreenivasan, A. and Subrahmanyan, V., *Proc. Nat. Inst. Sci.*, *3*, 219, 1937.
[5] Bhaskaran, T. R. and Pillai, S. C., *Science*, *90*, 595, 1939; unpublished data.

AMMONIA OF THE AIR

IN my article[1] an attempt was made more to convey a suggestion as to one possible cause of recuperation of nitrogen in Indian soils rather than to make a final conclusion. Careful and patient observations can alone bring out results which can settle the points on the other side of the question, *i.e.*, as to which of the two, gain and loss of ammonia is dominant. In fact, some work on the problem is already in progress at the Institute and the results will be published as soon as available.

In the meanwhile the points raised above by V. Subrahmanyan and S. C. Pillai need be considered in the light of observations we have already in hand. The authors themselves point out that sources of ammonia in the atmosphere other than the soil (if we take it for granted) are numerous. It need not be concluded that an "useful part" comes from the soil. It is well known that electric charges in the air cause formation of ammonia in the air itself.[2] Then, considerable quantities of ammonia come from volcanic eruptions and good amounts of ammonium chloride and ammonium sulphate have been known to occur in volcanic districts ; ammonia occurs with boric acid presumably formed by the decomposition of boron nitride.[3]

It is also doubtful if soils are more capable of giving out ammonia than of receiving it. Careful experiments are necessary to make any conclusion. If escape of ammonia nitrogen from the soils had been so continuous and quantitative as envisaged by the authors, there would have been a huge depletion of soil nitrogen every year by this agency alone and on this it would be very difficult to explain the ad-

vantages of following. As regards retention and release of ammonia from soils, Ingham's results with pulverised soil which he exposed in the air in the open for 18 months, are quoted below :[4]

Period (months)	Total Nitrogen %	Ammonia Nitrogen p.p.m.	Nitrate Nitrogen p.p.m.	Organic Nitrogen %
0	0·308	15	0·70	0·307
1	·315	54	11·0	·308
2	·321	97	12	·309
3	·318	157	23	·301
4	·322	172	23	·303
5	·330	234	29	·304
6	·339	280	30	·308
18	·350	418	30	·305

Thus it is seen that the remarkable increase in nitrogen was in the ammonia form and even during the period of 18 months there was no loss. Even if we imagine that there had been some loss by evolution of ammonia, it appeared that the net result of absorption and evolution was retention and not loss of ammonia from the soil. The possibility of bacterial fixation in the above soil was nil since soil organic matter underwent very little loss during the time (theory required destruction of half the organic matter) and the *p*H was 5·1, a very unfavourable one for azotobacter to thrive and function normally.

Another example can be found in Pusa drainage records which had been kept for about thirty years. Pusa soil with a huge amount of natural lime and a *p*H well above 8·0 (not to speak of 7·0) which grew wheat for a period of about 30 years did not show any remarkable loss of nitrogen when a balance sheet of nitrogen in the soil was prepared. The following were the results obtained.[5]

	Average annual loss of nitrogen from Pusa soil in lbs. per acre.
Nitrogen in drainage	9·95
Nitrogen in crop	21·58
Annual average loss	31·53
Annual average loss (from difference initial and final nitrogen content the soil)	32·00

All this go against the assumption that soils are more capable of giving out rather than receiving ammonia. The soils that are considered here were all unmanured ones and a very large portion of Indian soils grow crops without any kind of fertiliser. Studies in the losses of nitrogen from soil treated with heavy dressings of ammonium sulphate are of little value to actual agriculture in India.

Evidently the seat of absorption of ammonia is mostly the colloidal complex which is capable of absorbing ammonia in the gaseous form from the atmosphere and ammonia need not always be washed down in rain water to be absorbed by the soil.

However, it is really felt that the explanations in hand for natural recuperation of nitrogen of Indian soils are entirely inadequate. Studies of South African investigations on soils gave me impetus to make the bold suggestion without much experimental evidence to support it except for a few stray facts here and there. Naturally careful experiments are necessary and they alone will give us a clear picture of the natural process.

Subrahmanyan and Pillai's suggestion is welcome and we hope before long, to gain many valuable informations from their tried and experienced hands.

I thank them and my professor Dr S. V. Desai for the kind interest they have in the problem.

ABHISWAR SEN

Section of Soil Science & Agricultural Chemistry,
Imperial Agricultural Research Institute,
New Delhi, 12-12-1944.

[1] Sen, Abhiswar, SCIENCE AND CULTURE, *10*, 191, 1944.
[2] Arrhenius, S. A., Chemistry in Modern Life of Dr Leondard's Translation, 157, 1926.
[3] Partington, J. R., Text Book of Inorganic Chemistry, 3rd Edition, 546.
[4] Ingham, G., *South African Journal of Science*, *46*, 161, 1939.
[5] Sen, Abhiswar and Viswanath, B., *Ind. Jour. Agric. Sci.*, *13*, 537, 1943.

ATMOSPHERIC AMMONIA AND NITROGEN RECUPERATION OF SOILS

THERE is no doubt that a certain amount of nitrogen recuperation of soil is going on. A number of theories have been put forth, but no conclusive evidence is yet forthcoming. There is strong need, therefore, for a critical study of the problem in all its aspects. The subject is one of very considerable fundamental as well as practical importance.

V. SUBRAHMANYAN,
S. C. PILLAI

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 18-12-1944.

ON THE THEORY OF ADSORPTION INDICATORS

FAJANS, Kolthoff[1] and their collaborators have developed theories on the action of adsorption indicators. It has been shown by Chaudhury and Indra[2] that these theories are not in complete agreement with experimental results on cataphoretic velocities of silver halides under the conditions of titrations.

From Langmuir's adsorption isotherm, we have

$$\frac{x_H}{x_{Ind}} = \frac{k_1 a_H}{I + k_1 a^H} \times \frac{I + k_2 a_{Ind}}{k_2 a_{Ind}}$$

where x_H and x_{Ind} are the amounts of the halide and the indicator ions adsorbed ; a_H and a_{Ind} are the acti-

vities of the halide (and indicator ions) and k_1 and k_2 are constants.

Neglecting $k_1 a_{H+}$ and $k_2 a_{Ind}$ in comparison to unity, we have

$$\frac{x_H}{x_{Ind}} = \frac{k_1 a_H}{k_2 a_{Ind}} = k \frac{a_H}{a_{Ind}}$$

i.e., the amounts of the ions adsorbed are proportional to the activities of the halide and the indicator ions. When $\frac{k_1}{k_2} = K =$ unity, the ratio of the adsorbed ions is equal to the ratio of the activities of the ions in the solution.

The adsorption of the halide and the indicator ions should depend on the activities of the halide and the indicator ions in the bulk of the solution, on the adsorbabilities of the respective ions by the precipitates (say silver halide), and on the solubility of the precipitates.

For an indicator ion to be precipitated at the equivalence point, *i.e.*, for an ideal titration:

(1) The activity of the indicator ion used should be equal to that of the halide ion in the intermicellary liquid of the colloidal precipitate formed as a result of reaction between equivalent quantities of the reactants.

(2) Also the solubility of the silver-indicator compound should be equal to that of the silver halide compound since the adsorption of the indicator and halide ions depends on the solubilities of the silver halide and silver indicator compounds.

In very dilute solutions, the activities of ions may be taken to be equal to their concentrations.

In agreement with the theory developed above, the concentrations of the indicator ions used by different authors are found to be of the order of the concentrations of the halide ion.

The adsorption of the indicator ion which brings about the colour change, with which we are concerned in titrations, is very probably immediately followed by chemical combination.

S. G. CHAUDHURY

Department of Chemistry,
University College of Science,
Calcutta, 7-12-1944.

[1] Fajans, K., Radio-elements and isotopes; Chemical Forces and optical properties of substances, p. 96, McGraw Hill Book Co., New York, 1931; Kolthoff, *Chemical Review*, *16*, 88, 1935.
[2] Chaudhury, S. G. and Indra, M. K., *J. Ind. Chem. Soc.*, *16*, 81, 1939.

STUDIES IN THE CYCLOPENTANE SERIES—PART III

IN continuation of the investigations[1, 2] we intend to record some of the more important results in the following short note.

Pure trans-1-methylcyclopentane-1:2-dicarboxylic acid was esterified to give the diethyl ester (110°/6 mm). The half-ester of this, obtained on partial hydrolysis, was converted into acid-chloride which reacted smoothly with cadmium dialkyl to give the 2-methyl-2-carbethoxycyclopentyl methyl ketone (103°—05°/8 mm; semicarbazone: 200°—2°). The keto-ester reacted with β-bromo-propionic ester in presence of magnesium in toluene solution to give a lactonic ester (175°—85°/9 mm). This was reduced according to Clemmensen and the free acid was isolated as its diethyl ester (160°—65°/8 mm). Methylmalonic ester condensed with ethyl α-bromoglutarate to give the corresponding tetra-ester (185°/5' mm). This underwent ring-closure with sodium and the β-ketonic ester was partially hydrolysed with water-containing glycerol to give 2-methyl-2:3-dicarbethoxycyclopentanone (115°/4 mm, semicarbazone, m. pt. 240°).

The condensation product obtained from ethyl propionate and oxalic ester was brominated. The bromo-compound condensed under some modified conditions with the sodium salt of acetoacetic ester to give the keto-tetra-ester (132°/1 mm), which solidified in the receiver. This on dehydration with P_2O_5 gave the desired cyclopentenone derivative (133°/2 mm), which on catalytic reduction gave 2:3:4-tri-carbethoxy-3-methylcyclopentanone (126°/2 mm).

The lactone,[3] obtained by the action of α-bromopropionic ester on ethyl δ-isohexyl-γ-keto-hexoate in presence of zinc, gave the ethyl ester of the unsaturated isooctyl-methyl-cyclopentenone carboxylate (145°/4 mm), on treatment with P_2O_5. This on catalytic reduction gave 3-isooctyl-2-methyl 2-carbethoxy-cyclopentanone (150°—55°/8 mm). It was converted into cyanhydrin in the usual way and the latter was dehydrated to give the corresponding unsaturated nitrile (145°—50°/2 mm.) This was hydrolysed in a sealed tube to the desired dicarboxylic acid which was stereochemically impure to a slight extent.

The lactone (136°/6 mm) obtained by the action of α-bromopropionic ester on lavulinic ester was distilled over P_2O_5 to give the ethyl ester of dimethyl cyclopentenone carboxylate (90°—95°/6 mm; semicarbazone decomposes at 212°—14°). This smoothly took up hydrogen catalytically to give the corresponding saturated ester (90°/6 mm). This was hydrolysed to 2:3-dimethyl-cyclopentanone (B. P. 145°—50°, semicarbazone 179°—80°).

My grateful thanks are due to Prof. P. C. Mitter, M.A., Ph.D., for his kind help and encouragements during the course of this investigation.

PHANINDRA CHANDRA DUTTA

Sir P. C. Ray Fellow's Laboratory,
92, Upper Circular Road, Calcutta, 7-12-1944.

[1] Dutta, J., *Ind. Chem. Soc.*, 611, 1940.
[2] *Ibid.*, 79, 1942.
[3] Mukherjee, SCIENCE AND CULTURE, 7, 58, 1941.

ON VARIATIONS IN THE NUMBER OF GONADS AND SHAPE OF DORSAL TUBERCLE IN THE MONASCIDIAN *STYELA AREOLATA* HELLER

WHILE working on a collection of ascidians from Madras the author came across such a case in *Styela areolata* Heller, a monascidian that shows wide variations not only in the number of gonads but also in the shape of the dorsal tubercle, both of which have been considered as standard specific characters.

Heller[1], while erecting the species *S. areolata*, gave a very brief description without publishing any illustrations showing the structure. Herdman[2] while redescribing the species, states that in the few (4 on the right and 2 on the left) prominent gonads on each side of the body, this species recalls the arrangement seen in Shiter's eastern species *S. oligocapa* and *S. sedata*. My specimens although agreeing with Herdman's specimens in general, differ from them in the number of gonads on each side of the body. After studying a large number of specimens, I have come to the conclusion that this variation is individual and intra-specific. Similarly, the shape of the dorsal tubercle, which is considered as a standard specific character, shows variations in the turning of the free ends of the ciliated ridge, the ends of the horse-shoe being turned either in or out in different specimens.

The gonads in *S. areolata* are elongated, tubular structures that lie in the substance of the mantle, their ducts being directed towards the atrial aperture. The right side has more of these tubes than the left, and the tubes remain separate throughout their course, no junction or anastomoses occurring in neighbouring gonads. The right side has 3 gonads at the least; and I have found specimens with 4, 5, 6 and even 7 *gonads* on the right side of the body. As each gonad has its separate duct, the gonoducts also number from 3 to 7 on the right side. It is characteristic, however, that all these gonads, even when the number is 7, lie clear of and above the long tubular heart. The left side of the body, *i.e.*, the side bearing the loop of the intestine, bears the gonad in the intestinal loop in cases where only one gonad is present. But more usually the number on the left side is two, when the second gonad lies over or a little anterior to the dorsal limb of the intestinal loop. In a few specimens, however, a *third* gonad may be found lying clear of the intestine and the other two gonads. All these gonads are similar in structure to those of the right side and open separately by ducts at the base of the atrial siphon.

Each gonad consists of a central tubular straight or sinuous ovary, narrowed to a neck at its dorsal end, where the opening for the discharge of the eggs (oviducal aperture) is situated at the base of the atrial siphon. Each ovary contains a large number of ova in various stages of development. The testes consist of a number of caeca surrounding the ovary, except towards the dorsal end where they are absent. They are distributed around the ventral end of the ovary and along its sides, the characteristic feature being that the testicular caeca lie attached to the mantle a little apart from the central ovary. Each testicular caecum is irregular in outline and leads into a small spermatic *duct*, which unites with the others and forms a common spermatic duct, which opens separately near the oviducal aperture.



FIG. 1. Views of four specimens of *Styela areolata*, after removal of test, to show variations in the number of gonads.

The horse-shoe shape, characteristic of the dorsal tubercle of many ascidians, is specially recognizable here on account of the free ends of the horse-shoe being turned in, although not forming a spiral coil as seen in species of *Herdmania*.[3] I have, however, found in a number of specimens, the horns of the U being turned not in but outwards. In still other specimens only one horn is turned in or out while the other remains straight (*Vide* Fig. 2). Such a great



FIG. 2.—The dorsal tubercle of six specimens of *Styela areolata*, to show variations in their shape.

variation in the shape of the dorsal tubercle in *S. areolata* precludes, therefore, its inclusion in the chart of specific characters.

S. M. DAS

Zoology Department,
Lucknow University,
Lucknow, 29-12-1944.

[1] Heller, C., "Beiträge zur nahern Kenntniss der Tunicaten". *Sitz. Akad. Wiss.*, Wien. (Math. nat.) Kl., LXXVII (1), 1878.
[2] Herdman, W. A., *Report Pearl Oyster Fisheries*, V, Ceylon, 1906.
[3] Das, S. M., "*Herdmania* the monascidian of the Indian Seas". *Indian Zool. Mem.*, V, Lucknow, 1936; "On *Herdmania eunurensis* from Madras". *Proc. Ind. Acad. Sci. IX.* (1), Bangalore, India, 1940.

SCIENCE AND CULTURE

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SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—II.

IN the previous issue we have started a discussion of the place of scientific education and research in effecting an improvement in the standard of well being in this country. In considering the various suggestions which have been made, it was found necessary to distinguish between the strategy and the tactics of research. As a preliminary to discussion of our own problems we began with a short account of the discussions which have recently taken place in Great Britain on similar problems. We started with the assumption that conditions which are favourable for the promotion of fundamental research will also favour the advance of applied research, and that the necessary conditions for the promotion of the former are to (1) discover and train people who have the ability and impulse for scientific enquiry and also create conditions most favourable for their work and provide them with tools they need, (2) secure competent direction of research, (3) make provision on the basis of relevance to social needs for the organized study of particular and urgent problems, planned to advance science on an even front. These led us to consider the general problem of education of the community, including that of the adults and also of the rising generation. The former should be made to appreciate the value of scientific research as an instrument for national welfare; also it was necessary that provision be made for adequately trained and broadly educated workers for scientific research. Such education must provide a balance between the immense needs for scientific and humanistic studies. We are here particularly interested in considering the place of universities as a source of supply, both direct and indirect, of the type of personnel required, as also of their place in organized research.

Training and Research in Universities

In a recent report on university development by the Association of University Teachers in Great Britain, the functions of a university have been set forth as: the pursuit of knowledge not controlled or dominated by any private or corporate interest; the dissemination of knowledge and culture; further universities are schools of communal living in which the development of students as individuals and their development as social beings are equally important. Lastly universities are a part of society, both materially and intellectually, and bear a direct responsibility, and must, therefore, study the application of organized knowledge to practical problems and train men and women for particular tasks. While it is not the function of the university to inculcate any particular philosophy of life, it is assuredly an essential part of its work to assist its students to formulate adequate philosophies of life for themselves.

The first aspect of the function of a university may be further elucidated as a place for the advancement of science, and not merely for its conservation or diffusion, where different branches of knowledge are brought into contact and harmonious combination with one another, where education and research advance side by side.

It is necessary at times to undertake a certain amount of clear thinking on the restrictive influences which threaten the free development of advanced teaching and research. Two of them may be stated here. (1) There is a growing departmentalism of science, which tend to become more restrictive; boundaries of teaching departments have insensibly created artificial barriers to free enquiry. It has to be decided from time to time, how far it is necessary

to retain some of these compartments for administrative convenience, and at the same time also to realise the limitations they impose on the character of the training we give to our future investigators. (II) There is also a great danger in our preoccupation with specialists, which lies not in doing that job too well, but doing it exclusively. Professor Sigerist remarked, "If the German academic world surrendered so readily to reactionary forces, it was due largely to the fact that it consisted of men who were specialists and nothing else. If we wish to educate a citizen to be able to think in terms of science, and a scientist prepared to participate in social action, we must change our teaching." This brings up the relation of technological and other professional studies to university studies.

Place of Technology in Universities

Technological studies have significance not only in regard to the survival of the nation and the needs of the individual, but also in the advance and unity of knowledge. The danger which lies in carrying out specialized professional or technological training and research in separate institutions was recognized about a generation ago by Professor Smithells who advocated the embodiment of professional and technical education in the universities for the reason that a wider outlook may thereby be promoted. In some quarters it has been suggested that development of technical colleges into institutions of university rank, independent of universities, should not be encouraged. Rather they should be associated with their regional universities, like the Imperial College of Science and Technology in London. But according to others, the aim should be to develop such institutions on lines similar to the Massachusetts Institute of Technology, with strong post-graduate schools, and providing under-graduate teaching. Such institutes, it is suggested, have advantages from the point of view of applied research. If it is found necessary to establish such technological institutions, care should be taken to supplement the specialized training imparted in them with humanistic studies.

Other questions of importance to be considered refer to the quantitative aspect of the university expansion, the size of the university population necessary to produce the required number of research workers and teachers, and the number of universities required to cater for them. Additional grants will be necessary for this purpose and for improving the conditions and standards of existing departments. As an offset of some of the increased expenditure, it is suggested that there should be closer co-operation between the universities, particularly in regard to the development of schools of research and teaching, elimination of redundancy, and the planning to cover existing gaps. Another point on which attention may be directed in fixing the target of the number of students to be admitted to universities is the capacity of the society to utilize the students when qualified. There is also the danger of too rapid expansion when there is not a sufficient number of first class trained men to staff them. There must also be such relation between the financial rewards in a university career, whether of teaching or of research, and those elsewhere as to ensure that a due proportion of the ablest minds of each succeeding generation are attracted to such careers.

Relation between Teaching and Research

There are other problems in the basic strategy of research we have still to consider. One of them is the relation between the teaching and research in universities. It is accepted that teaching must be in vital touch with research, but we have to consider how far the two functions may be combined in the same staff. There is concensus of opinion that all research workers should be given the opportunity of expounding to others the significance of the field in which he is working, but we should also see that really great teacher with a genuine talent for exposition and for inspiring others should be given full scope. Such teachers are not necessarily great investigators also. Sir J. J. Thomson has urged that greater regard should be paid in making appointments to teaching posts, to the power of candidates to present a subject in a clear and attractive way. Those who have had the opportunity of attending courses given by J. J. Thomson and C. T. R. Wilson will appreciate the point in the suggestion.

There is further the question as to what provision is to be made to assist in bringing to the fore directors or managers of research of the requisite calibre. According to our views, universities should not be regarded as forcing houses for the production of leaders in industries or in other spheres. It is sufficient that training in universities is such that there are no impediments to originality and to those who possess creative and imaginative minds. There could be no greater blunder than to introduce into the selection of scholars to the universities considerations other than those of intellectual ability, originality and independence of mind. If the conditions in the schools and in the universities are right, character will be developed as a matter of course. Its selective influence will be felt when the graduate enters the larger world in so far as its importance is recognized by the community, just as physical fitness is recognized as important. Provision of senior research fellowships may be helpful for encouraging men of the right type for responsible positions in the direction of research.

We next come to the consideration of conditions by which the supply and quality of the men required

for positions of research, administration and production adequate to our needs may be maintained. This belongs to the purview of tactics of research.

The first requirement is that conditions of service must be made sufficiently attractive in all services in which scientists are employed, including the government services, industry and universities. In the universities there must be a reasonable balance between standards of remuneration and status between teaching and research posts. In addition to the improvement of salary scales, we have also to consider other factors which affect the attractiveness of a scientific career to men of outstanding abilities. Some fore thought is necessary in planning the extension of supply of personnel so as to keep a balance between supply and demand. Violent fluctuations with consequent intermittent, and perhaps wide spread, graduate unemployment can have a detrimental effect on recruitment. Some attempt on the part of institutions to formulate quantitatively, as far as possible over a period of years, their requirements for scientific and other academically trained personnel is highly desirable. It is also desirable, as pointed out before, to equip the scientific workers with more adequate supply of equipment and apparatus, and also to train up a sufficient number of laboratory technicians and to award diplomas to them. These technicians should be given improved status and pay. Next in importance to provision of adequate remuneration and equipment is the question of status. It usually happens that higher status is given to administrative posts, and research workers of proved administrative ability should not be debarred from holding such posts. There may be other workers of outstanding research ability who are ill fitted to hold such posts ; but this should not be considered as debarring them from obtaining equivalent status. Another factor which may increase the attractiveness of an industrial career in research is a liberal policy of freedom to publish the scientific aspects of applied research undertaken in industrial concerns. Publication of the scientific aspect of his work is the legitimate ambition of every research worker. Experience has shown that such ambitions are not inconsistent with the interests of firms engaged in competitive industry.

Interchange and Mobility of Research Workers

We have next to consider the factors which are best calculated to promote favourable conditions for creative work. Interchange and mobility of research workers is an invaluable stimulant to freshness of outlook and new ideas. Increase in the mobility of research workers, whether between one branch of industry and another, or between the universities and the Government departments, or between the industry and the universities, is not only essential to ensure the best possible distribution of the available supply of research workers, but is also a stimulant to creative thought and further makes possible corporate attack on common problems, especially on border line problems. There should be systematic provision for research workers engaged in industry to return to university or to spend a period at a specialized research centre, both to keep their fundamental equipment up to date and to derive refreshment from day to day contact with colleagues engaged in other fields of research.

Adjustment of the conditions of work so that they are more comparable with those in different fields is one of the means of facilitating such mobility and interchange, one of the most important of which is the institution of a common system of superannuation. One such means of interchange, particularly at the universities, is the sabbatical year, which will enable scientific workers to give undivided attention to research problems for a long period. The other is the granting of leave for purposes of original work and investigation. The second method is specially suitable for employees in Government department and in industry. This will enable easier interchange between industry and the universities. Such facilities for interchange will bring up the question of the choice of subjects taken up for investigation, and bear particularly on the question of freedom of science and of publication.

Relation between Industry and University Research

It is argued that universities should avoid all association with industrial research, of which the results cannot be freely published and made generally available. This attitude is taken up in regard to work performed wholly or partly in a university laboratory, both on the grounds that scientific work at the university ought to be carried out without profit motive and that secrecy always interferes with the free exchange of ideas among research workers and creates the wrong atmosphere for fully successful fundamental research and for teaching. The primary task of universities is for advancement of knowledge combined with teaching work of high standard, and nothing should be permitted which may to any considerable extent direct them to undertake the work which they would not undertake on its own merits. It is, therefore, necessary from the point of view of personnel as well as of organization to exercise caution in using university laboratories or research workers for applied research which would involve any restrictive conditions or slackening in the pursuit of knowledge. While it is right to guard against the danger of university departments falling too much under the influence of particular firms or industries to the detriment of their main task, the pursuit of

applied science in university institutions should not be limited, when this arises naturally out of the more fundamental work and can be carried on with full freedom to discuss the problem and to publish results.

The question of permitting research in university laboratories on behalf of the industry appears to be looked upon from a different point of view in several American universities, as can be judged from the following quotation taken from remarks made by A. R. Oplin in a recent discussion:

"Manufacturers are inclined to be generous in subsidizing research projects in universities and institutions. They are making available large sums of money for this purpose with few strings attached. The investigations are established under contracts with only enough patent protection guaranteeing the donor to ensure willingness to develop the findings in useful directions.

Most industrially sponsored investigations are conducted for a specific purpose under a project system. This often leaves gaps in scientific data, and it becomes the responsibility of universities and foundations to foster the less spectacular research needed to fill in the gaps so that the broad frontier of knowledge may constantly expand."

Thus in many American universities research foundations or administrative agencies are being established. These are non-profit making agencies established either to exploit patents arising out of university research or for undertaking under project system investigations on behalf of manufacturers. That the activities of such foundations may lead to undesirable results from public welfare point of view was pointed out by us in an account which appeared in the January 1945 issue of SCIENCE AND CULTURE under the heading "Storm Over Sunshine D".

PRESENT NEGLECT OF BIOLOGICAL AND SOCIAL SCIENCE

We have been discussing the relation of physical sciences to industrial research. According to many competent authorities, the future impact of biological advances in agriculture, medicine, nutrition and sociology may be of the same order of importance as that of physics and chemistry during the past fifty years. The demand for biologists in the post-war period is bound to be large, and this requires that biology should be given a more important place in the curriculum. A special survey is necessary for the expansion of research and the creation of additional chairs in such related subjects as genetics, ecology, biochemistry, veterinary sciences, etc. Closely related to these subjects are those of social biology and of social and preventive medicine. There is a further field of investigation where our research effort has been inadequate and where our technique is just being only developed, because limitations of scientific method in situations involving judgments of value have not been fully recognized. These refer to fields of social and economic surveys.

Thus it appears that for a proper use of our available resources in men and material an over-all survey should be undertaken at an early stage of the main objectives, as distinct from detailed or particular subjects of industrial and the chief branches of pure and applied sciences. Until this has been done we are neither in a position to make the intelligent allocation of priorities of grants, etc., which in post-war periods will be essential. From the point of view of the scientific workers themselves also, it is necessary that some attempt to sum up the requirements of research from a national point of view and to indicate the broad fields to be developed is equally important. It provides the universities with a rough basis on which to estimate the number of trained workers required both in total and in different branches of knowledge. Demands for workers in the natural sciences can then be balanced with those for workers in the growing body of statistical, economic, sociological and psychological studies of no less importance to the community and to the industry. But beyond this it brings to the research workers in any field a growing awareness of the relations of their problems to those of students of other fields. That consciousness, with the more intimate contact with research workers who are asking other questions and employing other methods, which should flow from the new and fuller integration of our research effort should help to breakdown the isolation with which scientific workers have surrounded themselves in the past.

ORGANIZATION OF RESEARCH AND TRAINING IN GREAT BRITAIN AND U. S. A.

We shall in this section give an account of how research is organized in Great Britain and also how such research and training for research is financed. A short account will then be given of the functions of similar organizations in the U. S. A.

At present research in Great Britain is carried on in five main groups of establishment *viz.*, (*i*) laboratories of the universities and technical colleges, (*ii*) research stations of the Department of Scientific and Industrial Research (D. S. I. R.) and of the Agricultural and Medical Research Council, (*iii*) Research Associations, (*iv*) research laboratories maintained by private firms and (*v*) research establishments of the Fighting Services.

I. *Universities.*—In relation to science the universities have a dual function of training scientific workers and of conducting fundamental research. According to recent estimates the university income of the U. S. A. (population 130 millions) is now more than ten times that of Great Britain (population 40 millions) and her research expenditure £70 millions a year is at least ten times as large.

Direct Government assistance to the universities in Great Britain now takes the form of annual grants from the Treasury amounting to £2½ millions, and is allocated through a Treasury Committee, called the

University Grants Committee. In addition, local authorities and other Government departments provide over one million pounds approximately. For the training of research personnel, the D. S. I. R. gives grants to 100 students. It is felt that both the number and the amounts of the grants should be increased as well as the range of subjects they cover. The medical and agricultural sciences should be similarly provided for.

Research work undertaken in the universities comprises (*i*) fundamental research, (*ii*) research on behalf of individuals and firms and at their expense, (*iii*) research on behalf of some of the Research Boards who do not maintain their own laboratories, but place their work at universities and elsewhere.

A need has been felt of relating the universities more intimately with the research effort of the country as a whole so as to facilitate the planning of that effort more effectively. Preliminary to that it is necessary to co-ordinate the research activities of the universities themselves. Proposals have been made to establish a universities' advisory council entirely free from Government control, whose function will be to advise, through its sub-committees, when and where new departments will be needed for investigations of newly opened fields of knowledge. The University Grants Committee which is a purely Government Committee will act normally on that advice and provide funds accordingly. Each university will have its own research committee to watch over departmental activities and present a total research budget to the university for transmission to the Grants Committee. Such research committees will also maintain contact with the relevant sub-committees of the Advisory Council.

II. *D. S. I. R. and its Research Stations, including those maintained by the Agricultural and Medical Research Councils.*—The work undertaken in the Government research stations deal with, the maintenance of accurate standards of length, time and weight, the conduct of researches in subject like astronomy and geology. They also undertake specialized forms of industrial research as factory lighting, ventilation as well as on industrial safety ; other investigations deal with problems of soil erosion, forestry, plant disease, water supply and many other problems in the domain of agriculture and health which have social as well as economic bearing. The programme of each research station is drawn up on the advice of a research board consisting of outside scientific men and industrialists, with representatives of the interested Government Departments. All of them are placed under the Lord President of the Council.

III. *Research Associations.*—These organizations were started about twenty five years ago, and include co-operative firms belonging to particular industries. Their essential feature is that they are to be organized by the industry concerned, who frame the programme of work to be followed and appoint the staff. The income of each association consists of subscriptions and donations from subscribing firms which is taken into account in fixing the Government contribution which is paid through the D. S. I. R. All results arising from the general programme are the property of the Association and its members, including patents, and no benefit accrues to the State from the financial advantages earned thereby. Some of the investigations are carried out extra murally in universities. The total expenditure of the grant aided association was estimated at £8,50,000 in 1943.

IV. *Social Sciences.*—These cover a wide field and are on the whole less well organized than the natural sciences. There is at present no organization which can act on behalf of the social sciences like the Royal Society on behalf of the natural sciences. Again there is no organization financed by the Government to assist research in social sciences parallel to the D. S. I. R., the Medical and Agricultural Research Councils. Subjects which come under this group includes Demography, Anthropology, Social Surveys, Economics, Administration, Education, Psychology.

Need has been felt for the organization of research carried out under direct Government auspices, for ensuring a wider view and of effectively correlating the work of the Advisory Councils of Scientific and Industrial, Medical and Agricultural Research. The organization should cover the whole social and economic field and provide the Government with the best impartial scientific advice on all matters of industrial development and on the application of scientific knowledge.

Organization of Research in the U. S. A.

The National Academy of Sciences was established by Abraham Lincoln during the time of the civil war for the purpose of advising the Government on technical scientific matters. When the first World War broke out there was such a tremendous volume of war research referred to the Academy that need for extra help was pressing. The Academy then established the National Research Council (N.R.C.) consisting partly of members of the Academy and partly of non-members to assist with its work. The two organizations formed a science and research advisory division for agencies of the Government. After the war the Council devoted itself to the furtherance of research in general but continued its co-operation with the Government scientific bureaus. When the present war broke out many people realized that much scientific research was needed by the War and Navy Department, and that the scientific effort should be organized under the Academy and the N.R.C.

After some discussion it was decided that a civilian research agency should be set up in the executive department for the duration of the war, which would be supplied with money to work on "new instruments and instrumentalities of war". This led to the creation of the Office of Scientific Research and Development (O.S.R.D.) The latter operates entirely by contracts with existing academic institutions, industrial organizations and government agencies. The method is designed to utilize to the utmost available facilities and personnel and to avoid as far as possible the construction of new large laboratories. Approximately 200 industrial laboratories and 100 colleges and universities are at work on O. S. R. D. projects.

The position of O. S. R. D. in the post-war period is at present under discussion. In a recent paper contributed to a N. R. C. Conference of Physicists, R. C. Dunn has a valuable paper on "To what extent is Government financial aid for training and research desirable?' Starting with the basic assumption that fundamental research is a public need and public responsibility, Prof. Dunn analyzes the sources of support of research and training in the U. S. A. These are (*i*) from funds of foundations and endowments, given either directly by them or through universities and research institutions acting as agents to foundations, (*ii*) research supported by industry and (*iii*) Government. The amount spent by the Government during the present war period is variously estimated to be between 400 to 600 million dollars per year. The question is raised whether the private foundations like the Rockefeller Foundation will be able to support fundamental research to the extent they did before the war, as many of them are self-liquidating organizations who will distribute their funds by the next generation. Of the remaining two sources it seems inevitable that Government will supplement and ultimately replace the foundations as supporters of fundamental research in science because the magnitude of many of these projects will be so large that private sources or industry cannot be expected to amass the sum required or take the risks involved. These research projects by their nature cannot be expected to yield immediate returns, and it is primarily to the foundations and to the universities they have turned for support and to the Government they must turn in future.

It is suggested that a Government granting agency should be started to replace or to continue the support which have been furnished by the O. S. R. D. and other research supporting committees, except that the type of support must be broadened to include all sciences, and that it should act as a clearing agency through which all sciences can communicate. In answer to the question 'who is going to own the results of research', two alternative answers are suggested. One that it shall be the primary requirement of those receiving public funds for research, that all research should be freely published, and that Government should be required to defend infringement suits brought against users of processes discovered and developed in projects supported by public funds. The other answer is the creation of a public non-profit patent authority like the research corporations of some of the American universities to own and administer the processes discovered and developed by public grants. Another question which has also been raised is how should training for research be financed? All advanced training is post doctorial and is open to very few persons at present. It is obvious that more fellowships for advanced training are necessary. Two possible ways of implementing this is suggested. First the creation of advanced study institutions maintained like State universities at public expense and second a Government fellowship board to be set up which will award fellowships and scholarships tenable at research institutions and universities.

Prof. Dunn then asks whether the chief problem is in the method of financing training and research or whether it is not the fundamental question of the divorce of support and control of research, *i.e.* the freedom for research workers and the prevention of interference and favouritism which every one fears as Government enters new fields of science. An obvious remedial mechanism is to interpose between the source of funds and the recipient, an independent board of scientists like the grant in aid committees but with some public representation.

It will be noticed that all the questions involved in the provision of greatly increased support of training and research in sciences by Government and industry in this country have been considered both in Great Britain and in the U. S. A. In the next issue we shall consider the application of the principles elucidated from the above discussions to conditions prevailing in India.

SOME FOOD AND NUTRITION PROBLEMS OF THE PRESENT AND THE POST-WAR PERIOD

V. SUBRAHMANYAN,

INDIAN INSTITUTE OF SCIENCE, BANGALORE

FOOD is one of the foremost necessities of the human race, and in spite of the frequently cited philosophic contempt for it, good and nourishing food has always been of considerable interest to the great majority of mankind.

Scientific interest in the subject is, however, only of recent origin and although much valuable work has been done, especially during the past few decades, many of the outstanding problems still remain unsolved. A fresh approach is also needed in some important lines.

About eighteen months ago, representatives of forty-four nations met at Hot Springs, Virginia, and evolved what is now popularly known as the 'International Yardstick' for nutrition. The Conference laid down that, depending on age, profession and other conditions, every man, woman and child would require certain quantities of the essential food ingredients for the maintenance of normal health. Thus, the adult would require food with a calorific value of 2,500 and containing about 70 gms. of protein, about 1 gm. of calcium, about 12 mg. of iron, 5,000 International Units of vitamin A, about 2 mg. of vitamin B_1, 15 to 20 mg. of nicotinic acid, about 75 mg. of ascorbic acid and about 400 units of vitamin D. There are also small requirement of other vitamins, minerals, etc., but these are usually found in the common food. It is only occasionally that one comes across gross deficiencies of copper, iodine and such other elements.

The task of the nutrition expert is a very difficult one, and while prescribing standards such as the above, he is painfully conscious that he has to compare hundreds of substances which come in the same category. He has also got to prescribe for different economic levels and in this he has only the gross composition to go on.

Starting from only the gross analytical figures, it should be possible to evolve a cheap diet consisting exclusively of cereals, pulses and related products, greens, oil and salts and containing the same food essentials as an expensive diet consisting of meat, fish, milk, eggs, butter and vitamin concentrates together with adequate amounts of carbohydrates and minerals. Even animal experiments may evoke nearly the same response from the two sets of diets, but they are still not strictly comparable as articles of human food. The diet prepared out of the second group of food materials leads to much faster growth, protects against a variety of diseases and is, in every way, superior to the one prepared out of former group. It is here that the International Yardstick fails; gross chemical composition and even animal experiments are not sufficiently dependable in so far as human response is concerned.

To cite a few instances, substances possessing the same calorific value are not burnt to the same extent by the human body. Proteins from different sources are not utilized to the same extent. In spite of their high biological values, some of the pulses are highly indigestible and cause serious disorders if taken in more than moderate quantities. Mineral and vitamin deficiencies are not uncommon among people eating plenty of leafy vegetables and fruits. These and other items of evidence would suggest that there is a further factor that determines the utilization of foods, and that all foods must be evaluated from a new angle.

The significance of the foregoing will be further realized when we compare the food of man with those of animals. Taking for instance, the domestic animals, such as the cow, the buffalo and the pig, we find that they eat fairly coarse types of food which man cannot ordinarily hope to digest. They utilize this food to build up their body materials which are ultimately utilized as a good form of human food.

Let us now turn to another side of the picture. The sewage, as represented by a mixture of domestic and other wastes is of a composition which cannot be used as food even by the common animals. It is, however, utilized by some of the lowest forms of animals (the protozoa) which, in presence of air, build up their body materials out of the conglomerate of waste materials represented by sewage. The protozoa are, in turn, utilized by worms and insects and the latter are used by fish and other fauna as their food. The fish makes a high class article of human food. A somewhat similar series of changes takes place in the sea, where the lowest forms of life build up the starting materials and these, in turn, are utilized as food by the higher forms.

The foregoing observations would show that the lower forms of life are endowed with digestive mechanisms which enable them to utilise a variety of forms of organic matter. The higher animals have also got efficient digestive systems and are able to break up and build their tissue materials out of a variety of coarse materials. Man requires softer forms of

food and that in a cooked condition. Speaking comparatively, his digestive system is far less efficient than those of the lower animals.

It is true that persons in certain walks of life are able to utilize even very coarse food materials. They can even stand a certain amount of pollution of the drinking water. These are, however, only exceptions. The average man—especially one in a sedentary occupation—is unable to make proper use of coarse food materials. He requires soft and prepared food in a readily assimilable form. From this point of view, animal foods are usually more readily utilizable than the coarser vegetable food materials. This difference must be made up if vegetable food materials are to rank in the same class as animal products.

Every form of life is described by the physiologist as being made up of a number of autocatalytic systems. Once the framework of life is granted, the living cells are capable of transforming food materials into more living cells, and thus building up bigger and bigger systems until a certain limit is reached. In other words, if the food substances contain all the principles that constitute the cell materials, the living matter will automatically transform them into more cell material and thus build up a bigger and healthier system.

There is no doubt that vegetable food materials contain all the principles required by the animal body ; but the human system is unable to make as good a use of them as the lower animals can. The tissues of the same animals (which are closely allied to the human tissues) represent a concentration of the essential ingredients collected out of vegetable food materials. In this manner, the animal serves as a useful intermediary in collecting concentrated food for man.

In recent years, a great deal of work has been done on the chemistry of the muscle and the active principles contained therein. It is now realized that apart from being a rich source of protein and minerals, the muscle tissue consists of a number of living systems which are responsible for many of the important transformations in the animal body. Such systems are usually made up of combinations of proteins, minerals and vitamins. The essential hormones can also be built up out of animal tissue material. It would thus be seen that animal body material would constitute some of the best food materials out of which more animal tissues can be built up.

The above facts, though of profound scientific interest, are not universally applicable for a variety of reasons. Firstly, not many can afford a rich diet containing a suitable blend of animal and food materials with vitamin concentrates. Secondly, not many will eat such a diet because of religions and sentimental considerations. The position will continue to be the same and, if anything, it will become worse with the passage of time, especially, in thickly peopled countries like India.

It is well known that even under favourable conditions, agricultural production can increase only by about 30%, whereas human population can easily double itself in a few decades. With improved health and sanitary measures, protection against epidemics and so forth, the population in a country like India will increase enormously and will soon outstrip agricultural production. No amount of improvement of agriculture during the post-war period is going to keep pace with the requirements of the growing population of the country. Sooner or later, there is bound to arise fresh difficulties in the matter of food over different parts of India. There will be very little of food for man and still less for animals. In such a competition, the animals will be the first to suffer and then man will follow.

Such a problem has already arisen in China where the animals have been steadily disappearing. A large section of the people do not eat any meat ; they do not even get any milk, so much so that they have gone off the habit of using milk. They have evolved a system of using purely vegetable food materials which are raised primarily for meeting the needs of man. In course of time, the crowded parts of India are bound to be thrown increasingly on purely vegetable food materials with fast diminishing quantities of animal food. It will follow that, apart from every other consideration, vegetarianism will be forced over a large part of India unless effective measures are taken to check the increase in population.

Taking the above facts into consideration, it would follow that the task of the nutrition expert will soon become one of providing adequate and easily assimilable diet out of purely vegetable food materials for a large section of the population of the country. As already mentioned, vegetable food materials, especially of the coarser type, are not easily digestible, so much so that if this defect is not removed, mal-nutrition and under-nutrition will prevail even in spite of the apparent adequacy of the diets.

Examination of the gastric secretion of a large number of persons, as also of children, suffering from mal-nutrition and related disorders have shown that they have very low powers of digestion. Continued eating of poor and coarse food materials has affected their power of secreting their digestive juices, and consequently they are unable to build up the essential reserves. In this manner, the deterioration will go on until a very low level of existence is reached. This vicious circle must be broken up at some point by suitably modifying the vegetarian diet so as to render it more easily digestible.

Processing of foodstuffs to improve their digestibility is well known and practised all over the world. The commonest method is cooking. Steeping and germination are also generally known, though not universally practised. Leavening is a method of processing for making bread and other similar preparations more digestible. The number of methods known and practised are fairly limited and excepting in a few cases, they are not sufficiently effective in achieving the desired end. The people concerned with the preparation of food, generally, the housewives, are usually very conservative, and they will not readily change from the methods handed to them from one generation to another. It is here that science has to come to the aid and help to educate the people to adopt new and improved methods of processing foods.

Not many years ago, there was a good deal of active propaganda for the use of the wonder bean, the 'Soya', as an article of household diet in India. Not many were first willing even to try it ; even those who tried, had followed the usual traditional methods of cooking and found that, under such conditions, it was no better than the common Indian pulses. Some even found it to be highly indigestible. Nutrition experts who compared it in the conventional way with the other pulses found it to be in no way, superior to the ordinary pulses. The fact still remains that in other parts of the world, especially in China and Japan, it has really proved to be a very valuable article of diet and has helped people to maintain excellent health in spite of the necessity of having to give up meat and milk.

The reason for the above divergence of experience lies in the method of processing employed by the users. In China and Japan, the soya is never cooked and eaten whole. It is usually first processed to yield the milk which is subsequently utilized in different ways. The elimination of the roughage, the colouring principle and the bitter principle tend to improve the appearance, the taste and the digestibility of the pulse and hence its utility as an article of human food.

Similar and even more improved methods are possible in regard to the other articles of food. One of the best methods is to treat the food at the appropriate stage with small quantities of digestive enzymes of animal or vegetable origin so that the food material becomes soft and easily penetrable to the digestive juices of the body.

In cases of extreme deficiency of digestive juices and under conditions in which no form of processing is possible, use of predigested and concentrated foods will be of utmost importance in building up healthy reserves of body material and in facilitating resistance to infection of various types.

Over-processing of foodstuffs should of course be avoided, especially in the case of normal people, as that will tend to reduce the normal processes of secretion and even encourage easier and more sedentary habits of life. Adopted with discretion it should be of great value in bridging the apparently enormous difference between rich animal diets and coarse vegetarian food.

The time has now come when the increased application of science to the processing of foodstuffs, not only to improve their taste but also their digestibility and general food value, is badly needed. This should definitely be one of the post-war programmes of work in India.

Thanks to the exigencies of war, India has now an active department of food. This department has now a unique opportunity to initiate work in the above and related subjects. It is hoped that the opportunity will be made the fullest use of not only in standardizing and applying already known methods of processing, but also in sponsoring work that will lead to the development of new methods that can be used both for meeting the present requirements and for successful practical application during the post-war period. That will be the greatest service which the Indian Food Department will be rendering to the country and, to some extent, to the world in general.

CONSUMER SCIENCE IN INDIA

R. L. MOORE,

DEHRA DUN

CONSUMER science, or science applied to the problems of the consumer of goods, is a highly specialized study in America, but in India it does not seem to have made its appearance. In a perfect society consumer science would be the handmaid of producer science, the science of the manufacturer but unfortunately the two sciences are often at cross-purposes.[1] Consumer science attempts to assess the real value of goods or services available to the consumer. Producer science on the other hand is attempting always to discover the easiest way to flood the market with profit-making goods. In our

present social system producer science is dominant and consumer science recessive. Backed by industrial wealth and brains, and with perfect understanding of the consumer's psychology, producer science in every way overshadows the ineffective attempts of the consumer to discover what goods or services are most profitable to him. Even the most gullible consumer sooner or later realizes that he has had a bad bargain, but the ease with which hair restorers or patent medicines are sold gives some indication of the feebleness of the consumers' mental processes. The fact is that the consumer seldom realizes that pure milk at Re. 1/- per seer is a better bargain than a 50 per cent milk and water mixture at nine annas; that a toothbrush with nylon bristles costing 30% more than an ordinary one is much better value for money. These are the sorts of questions the consumer needs to get answered if he is to keep his head above water in a world where his rupee can only buy six annas worth of goods. Some ways in which a scientific approach might be made to the problems of a consumer of moderate means in India are outlined below.

The Buying of Fruit

One interesting social effect of the war is that inflation has brought the middle classes into the bazaar to do their own shopping. One of the most difficult problems is the purchase of fruit. Why does one buy fruit at all? Many people buy it simply because they like it, but this reason, for the 'new poor', is not in itself a good enough answer. There is a reason beyond this; fruit, because it can be got fresh and eaten uncooked is the best source of vitamin C (ascorbic acid). Vitamin C,[2] we are told, is necessary in adequate doseage for buoyant health. There are other factors available in fruit which can equally well be obtained in vegetables, cereals or pulses. If fruit is an essential part of man's diet then the reason for it is that it is a sure way of getting an adequate supply of the anti-scorbutic vitamin.

The Director, Nutrition Research Laboratories,[3] estimates that some 30-50 mgms. of vitamin C are required daily by both children and adults. Suppose 40 mgm. per day is taken as the amount we require from fruit, and let us hope that the rest of our diet is able to supply another 10 mgms. The consumer's problem is simply to find out how to get the 40 mgms. as cheaply as possible. He finds many kinds of fruits available, at different prices; some he likes, some he does not; and furthermore to complicate matters he discovers that they all have different vitamin C contents.[4] The following table analyzes the problem progressively and needs little explanation. Prices are calculated from average control or market prices in Dehra Dun in 1944. In column 3 is given the cost of depending for one's 40 mgms. of vitamin C on a particular fruit. Column 4 gives the economy rank, No. 1 representing the most economical fruit. The last column labelled 'Economic factor' is to enable consumers in other price areas to find their most economical fruit. If the prices of the quantities mentioned (seers) are filled in for any place the lowest figure will correspond to the most economical fruit.

TABLE 1

Name of fruit	1 Rate per seer (Rs.)	2 Number of seers to give 40 mgm. vitamin C	3 Cost of 40 mgm. vitamin C	4 Economy rank	5 Popularity rank	6 Economic factor
Amla	0·62	0·0073	0·0045			
Apple	1·5	2 2	3·3	10	3	1 0
Banana	0·66	4·4	2·9	9	4	300
Cape gooseberry ..	0·31	0·09	0·028	3·5	7	600
Grapes (blue) ..	3·0	1·5	4·5	11	2	12
Guava (country) ..	0·31	0·015	0·0047	1	5	200
Lemon juice ..	0·25	0·11	0·028	3·5	9	2
,, fruit ..	0·13					15
Mango	0·75	0·34	0·26	6	1	
Melon	0·25	4·4	1·1	8	8	46
Orange	0·62	0·065	0·04	5	6	60
Papaya	0·25	0·096	0·024	2	10·5	8·9
Tomato	0·5	0·14	0·70	7	10·5	13
						19

From the table, it is concluded that the common fruits, amla, papaya, guava, lemons which are looked down upon by the well-to-do, can prove the poor man's salvation, for these fruits with their high vitamin C content are by far the most economical purchases. Referring to column 2 it will be seen that the consumer's capacity will be sorely tried should he attempt to get his daily dose of vitamin C from grapes, apples or bananas, and yet these seem to be very popular fruit.

There appears to be some obscure connection between the vitamin C content of fruit and its popularity, and in order to investigate this further a survey was taken of the likes and dislikes of two batches of school boys, each batch composed of 14 boys. Their ranking of various fruits in order of popularity is shown in column 5. From the table, the following correlations were obtained.

Correlation between

1. Popularity and price per seer ... rho = 0·8
2. Popularity and vitamin C content ... ,, = −0·3
3. Popularity and economy rank ... ,, = −0·6

From the first correlation it is seen that there is a high correspondence between how much one likes a fruit and its cost. The more expensive a fruit is the more it is liked. Put otherwise it may

be that because everyone likes a certain fruit it becomes expensive, which is of course the conclusion which the ordinary laws of supply and demand would lead to. It also seems clear from correlation 2 that the more vitamin C there is in a fruit the less one likes it, and from 3 the more economical a fruit is the more it is despised. For the harrassed father this is bad news, and the probable explanation is that ascorbic acid is found most abundantly in fruits of an acid nature, and the resultant sourness diminishes its popularity.

Amla was not considered in the popularity survey or given an economy rank for the reason that few people seem to have tried it. As it is the richest natural source of vitamin C and also the most economical purchase, any consumer who finds his fruit bill giving him sleepless nights should consider laying in and preserving a stock between December and April.[5] In conclusion it may be said that by purchasing the cheaper varieties of fruit only, as indicated in the economy rank, the consumer can cut down his normal fruit bill very considerably, as long as he is willing to face a certain amount of unpopularity by so doing.

The Buying of Fuel

A large item in the family man's budget nowadays is fuel, both for heating as well as cooking. Most householders are guided in their purchasing by principles of food economics learnt in pre-war days, but fuel costs have risen so unevenly that the careful consumer needs to re-examine the question of fuel economics. This is clearly the sort of problem which a consumer science might tackle and the two tables (table 2 and 3) represent the results of a preliminary investigation.

Fuel for heating the house.—For real economy of course the consumer can do without any fires and sit and shiver in the winter, but in many places in India people are accustomed to some sort of room heating in December and January. The fuels generally available are: coal, wood, charcoal or electric power, and a rather inefficient fireplace or an electric fire are the appliances in which energy can be utilized for heating a room. Each of the fuels mentioned contains a different amount of energy per pound and the prices are also different. The first consideration is the number of heat units available per rupee. This data is given in column 3, table 3.

This, however, represents the heat which would be available from perfectly dry fuel, burnt in an ideal grate from which no heat was wasted, both of which conditions are far removed from reality. All fuel contains some moisture and we can only make a guess as to its amount. In the case of steam coal and charcoal the moisture becomes easily noticeable if it exceeds about 20%. 10% has been taken as the average moisture content of charcoal and coal if purchased with care, but the seasonal phenomena of the influx of charcoal sellers after rain should be a warning to all consumers. It is also worth while noting that steam coal is in a process of slow combustion, and coal hoarders are likely to find the stock pile a good deal lighter each year.[6]

The probable moisture content of fuel wood is much more difficult to estimate. Freshly felled logs may contain 100% moisture, that is, a maund of wood after drying will weigh only 20 seers. The water content of wood depends upon the season in which the wood is felled and length of time it is stacked after felling. Experiments carried out by the Forest Research Institute show that it may take as long as six months for billets to dry out to a 10% moisture content. Wood never becomes quite dry, in fact thoroughly air-seasoned timber averages between 7 and 15% moisture content depending on the place. Few consumers are able to purchase wood in this condition. The consumer rarely knows when the tree was felled or the length of time for which it has been stacked after felling, or possesses the time or equipment necessary to gauge the moisture content of the wood. The amount of water he is buying with his wood we know will lie somewhere between 10% and 100%. As a rough guess we may figure on a probable moisture content of 40%. This corresponds to sal billets from a tree felled at the end of November and stacked for about four months, or sal felled in early May and then stacked for 1½

TABLE 2

Source of heat	1 Price per md. at Dehra Dun	2 B. Th. U per lb. of dry fuel	3 Apparent B B. Th. U per rupee	4 B. Th. U per rupee allowing for moisture	5 Net B. Th. U	6 Economic factor
		Approx.				
Charcoal ..	Rs. 3- 8-0	12,000	270,000	250,000	50,000	3·7 lb.
Coal ..	Rs. 1-14-0	14,000	600,000	540,000	108,000	3·2 lb.
Wood ..	Rs. 1- 0-0	8,800	705,000	505,000	101,000	6·4 lb.
Electric Power ..	Rs. 0- 1-0 per K.W.H.	—	54,000	54,000	54,600	3·4 K.W.H.

months.[7] Column 4, table 2 shows the heat value of wood fuel on this supposition.

It must not be imagined that even this figure represents the heat the consumer is going to circulate through his house, as so far consideration of the method by which the fuel is actually burnt has been neglected. Even a good grate only sends 20% of the available heat into the room.[8] The rest goes up the chimney and is lost for ever. Good grates are rarities but when this optimistic correction is applied the result is shown in column 5, table 2. It is seen that coal and wood are the most economical and charcoal should be ruled out entirely. When one remembers that electricity causes no smoke, gives off no fumes, and can be switched on and off as the occupant leaves the room, then it too is worthy of consideration as an economical way of room heating.

The troubles of the cousumer as he searches for dry fuel should draw his attention to a solution. Why should wood or charcoal be bought by weight? If they could be bought by volume all would be well. There is in existence an old English measure for wood, the cord, which is a pile of wood 8 ft. long, by 4 ft., by 4 ft., and of course the charcoal sellers' kandi is a volume measure although there appear to be at least two sizes. Surprising though it may seem the average density of piles of irregular objects of reasonably similar size remain remarkably constant.[9] The volume of a pile of wood therefore would be more likely to represent its heat value than its weight.

The economic factor in column 6, table 2 enables similar estimates to be made of fuel costs in other price areas.

Fuel for cooking.—In using fuel for cooking it is not difficult to measure experimentally the actual heat one is getting for one's rupee with various fuels. Here the fuel used should be thoroughly air-dried. People do not usually try to cook on damp sticks although they may try to warm a room with damp logs.

The following fuels were tested: wood, charcoal, sawdust, together with electric power. The wood and charcoal were burnt in an angiti of 7½" in diameter, the sawdust on a similar sized sawdust burner, and the electricity was used in the usual coiled nichrome wire set in an open porcelain matrix. In each case the heat was used to warm a large degchi and, after making a radiation correction for the degchi, the effective heat energy obtained was calculated. The results are given in table 3.

TABLE 3

Source of heat	1 Total B. Th. U. per lb. (gross)	2 Price per md. (D/Dn)	3 Efficiency* Actual heat / Gross heat	4 Actual B. Th. U per rupee	5 Rate of working B. Th. U per min.	6 Economic factor
Charcoal	12,000	Rs. 3- 8-0	31%	86,000	37	9·2 lb.
Sawdust	8,800	Rs. 1-10-0	24%	102,000	24	16·3 lb.
Wood	8,800	Re. 1- 0-0	22%	156,000	60	17·8 lb.
Electric Power		Re. 0- 1-0 per K.W.H.	63%	34,500	29	16 K.W.H.

Here again it is apparent that while charcoal is an uneconomical fuel in this price area, wood is the cheapest, followed by sawdust. Electricity again merits consideration for occasional heating as there is no loss in kindling or wastage after use.

The Consumer's House

In North India the average man* when not too busy, spends much of his time either trying to keep cool or to get warm. He may live in an old fashioned house with immensely thick walls which while cool in the summer months is chilly and dark in the winter, or else a modern house, ideal in winter but too bright and hot in the summer. The remedy for all this is a light airy house fitted with some kind of air-conditioning. Unfortunately to cool a whole bungalow is a very expensive proposition, a plant for a very small house costing in the neighbourhood of Rs. 2000/- and consuming one horsepower or more, night and day. This sort of outlay is beyond the means of many people, and even then the heating of the house in the winter would have to be done in some other way.

Professor Thoburn of Lahore has recently been investigating the possibilities of a cheap form of air-conditioning, utilizing the earth as a great heat reservoir, which well deserves consideration. Consider the annual temperature variations at Lahore as being typical of North India. The temperature averaged over the last 65 years has varied from 40° to 110° annually. If 5-day mean-maxima and minima are considered the all-year mean temperature is 76°F.[10] Now 76° is distinctly chilly in the hot weather and yet beautifully warm in the winter.

* An average man--one whose income is between Rs. 100 and Rs. 1,500.

Cannot we avoid the extremes? We can of course if we go to the sea coast where the sea acts as a gigantic heat reservoir smoothing out the sun's variations and producing an equable climate all the year round. In North India there is no sea, but there is the earth. It also acts as a reservoir of heat energy but in a different way from the sea. When the sun's rays beat down upon the earth in summer the upper layers get warmed and this wave of warmth passes slowly into the earth. By early winter, when the upper earth is cool, this wave of warmth, now somewhat reduced in temperature extends between 6 and 15 feet below the earth's surface. Deeper still the annual temperature variations die away slowly and the earth eventually remains at the all-year mean temperature of 76°F. (There is an increase of temperature below the surface of about 1°F per 40 feet but this can be neglected).

One could, therefore, live at this ideal temperature of 76° if one built one's house underground. This is not news in India for one has only to visit the Emperor Akbar's Fort at Agra to find a well which has a series of five rows of rooms around it all below ground level.[11] The air-conditioning lessons of the Moghuls have been forgotten, but Thoburn's scheme is better than theirs. He wants the house built in the ordinary way, but with fewer doors and more windows and capable of being shut up. Underneath the house he would arrange, some 20′ below ground level, a series of tubes in such a way that, by means of a fan, air from the house

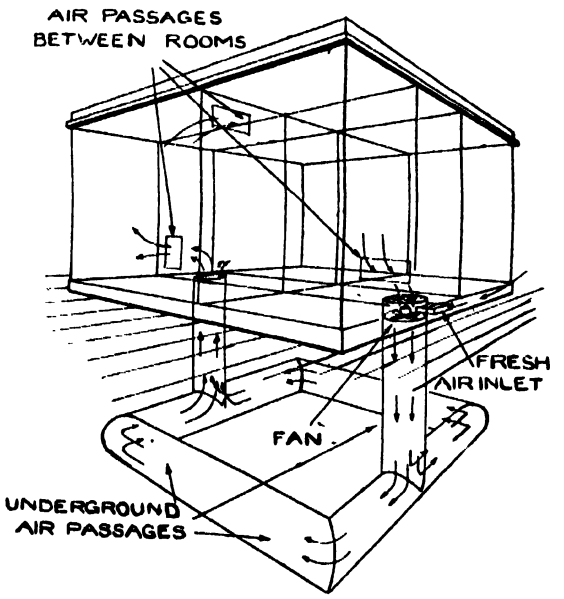


Fig. 1. Earth-heat Air-conditioning

could be sent 20 feet below ground level to return *cooled* in summer and *warmed* in winter. The whole scheme is illustrated in Figure 1. The fan can also draw a regulated supply of fresh air from outside. The direction of air flow is shown. Although the bungalow would be shut up it is not gas-tight and the vitiated air would gradually leave through the many cracks and spaces which exist in any building. It will be noticed that there would be a continuous movement of air from room to room which would mean that the use of fans would be unnecessary.

There are plenty of difficulties to be faced in designing such a house. How rapidly will the earth absorb or give out heat: how fast must the air move so as to be able to transfer its heat to the walls of the subterranean tubes: how much will the scheme cost? These problems have been tackled experimentally and mathematically, and Prof. Thoburn thinks he has the answer. To get a very rough idea to show that the quantities of heat involved are of the right order let us suppose that in the summer the underground pipes can get rid of their heat to a volume of earth $40' \times 40' \times 40'$. Take the density of soil as 2·0 and the specific heat as 0·2 and assume that this volume of earth shows a mean increase in temperature at the end of the hot season of 10°F. The earth will then have absorbed 16,000,000 B. Th. Units. This is equivalent to 1 ton of refrigeration for 55·5 days or the heat required to melt 55·5 tons of ice at 32°F which is a very useful amount of cooling for the hot season. When winter comes there is now a well warmed heat reservoir underneath the house, and the heat which was absorbed in the summer will now be available in the winter. Suppose with the winter circulation the temperature of the volume of earth underneath the house now fell from 10° above the mean to 10° below. This would mean that 32,000,000 B. Th. Units of heat would be available. This is equivalent to over 80 maunds of best quality coal burnt in a grate with 20% efficiency. There is of course much more to it than this simple calculation shows. As far as my present information goes no one has the desire or time to try something which might make a tremendous difference to Indian living conditions. However civil engineers are so steeped in folk lore and old-fashioned ideas that it may take some time for this new-fangled idea to penetrate!

The Consumer's Car

For many people, next to the house they live in, a motor car is their largest capital investment. One would have thought that in such a serious matter the consumer would be able to turn to some capable, disinterested party for advice on how to invest his money, but in very rare cases is it possible to obtain such advice. The first business of the consumer when facing the problem of car purchase

is to consider it in its personal aspect under the following headings.

Personal factors :—

(1) How much cash is available?
(2) How big is the consumer's family?
(3) Have the wishes of the wife to be considered?
(4) What is the car required for?

The amount of cash available determines whether the car is to be a new or a second hand one. As the purchase in many cases will be a post-war one the very steep slump in used car prices when new cars commence coming on to the market is a factor to be reckoned with. It may be better to wait for the new car.

If the car is to be used by a family the disadvantages of having a car just too small should be carefully considered.

The best wives always agree with a husband's choice in the matter of cars. The most difficult type seizes on irrelevances like the colour of the upholstery as reasons for their choice.

If the car is going to be used entirely for town work a small car might serve, but for anything in the nature of rough going a big car is essential for economical service.

Having considered personal factors the consumer should now try and understand what he pays for when he buys a car. In the case of the mass-produced car the cost is determined almost entirely by the weight. On the basis of 1940 prices British and American cars averaged about Rs. 2-4 a pound, about the price of butter. In the high powered range British cars tended to weigh more and were dearer than their American counterparts. If one has the money then a non-mass-produced car is a better car, but it is not an economical purchase in that giving three times the price does not mean that one gets a car with three times the life. For the average man, however, the choice lies between British and American mass-produced vehicles. For real economy the British 8 or 10 h.p. cars take a lot of beating, but among the larger cars experience shows that the American car is the most economical in India. British car designers have always been hampered by a stupid taxation system,[12] which has meant that the designer has always been trying to circumvent the tax rather than produce the most efficient engine. British cars of higher power are thus heavy on petrol for their size, slow in acceleration, and are made in such a multiplicity of sizes and types that buying a spare part in India is a heart-breaking business. The belief of most Englishmen is that British cars wear longer. Certainly their coachwork is superior and rattles less but I doubt if there are any statistics to show that the mechanical part of the American car is in any way inferior. From press notices one gathers that British makers are concentrating on export models which it is hoped will compare favourably in both performance and *price* with post-war American cars.

There is something different about the possession of a car from the possession of other objects. A car in some way, like a house, reflects the personality of the owner. A flashy person has a flashy car ; the wealthy business man travels in a car the size of a truck ; the man who does not bother about appearances has a creaking, ramshackle vehicle. For this reason the modern American feels it his duty to have a fresh car every year : he lives in a go-ahead country and must always be experiencing the newest and the best. This wish to keep up appearances does not apply to other consumer goods. No one scraps his bicycle or her sewing machine because it is out-of-date. The reason is not far to seek : a bicycle does not express personality ; no one can make a dignified entrance on a bicycle. Also bicycles and sewing machines have not changed in essential

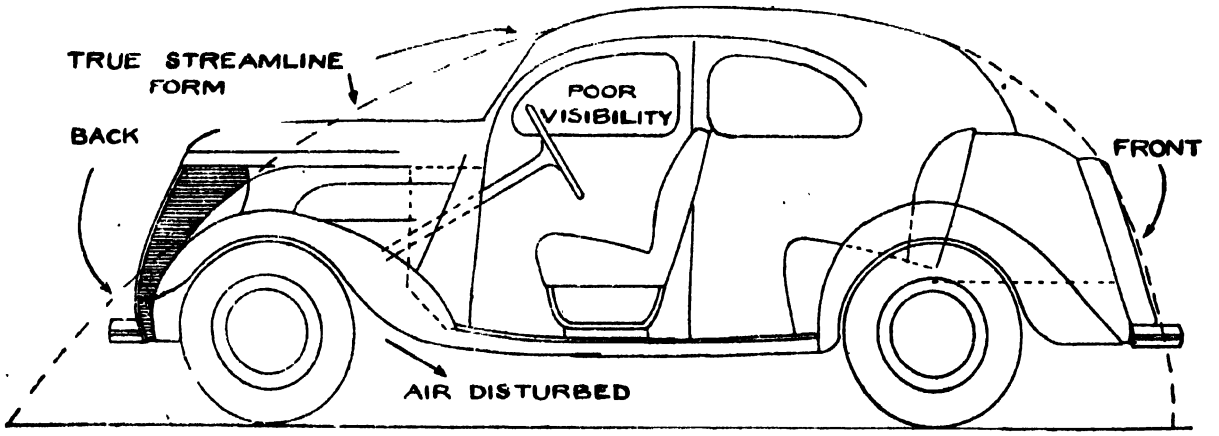


Fig. 2. The Car of Today

features or in external appearance for the last 30 years. Now all this is of considerable importance to the consumer who is about to purchase a car. Has he bought something which will last or has he merely entered a vicious cycle of car followed by new car. If only he were sure that the car he buys in 1946 would look pretty much the same as the car he could get in 1965 he would feel a good deal happier. I shall now endeavour to show that the general shape of the motor car will soon settle down to one particular shape and then remain like this indefinitely.

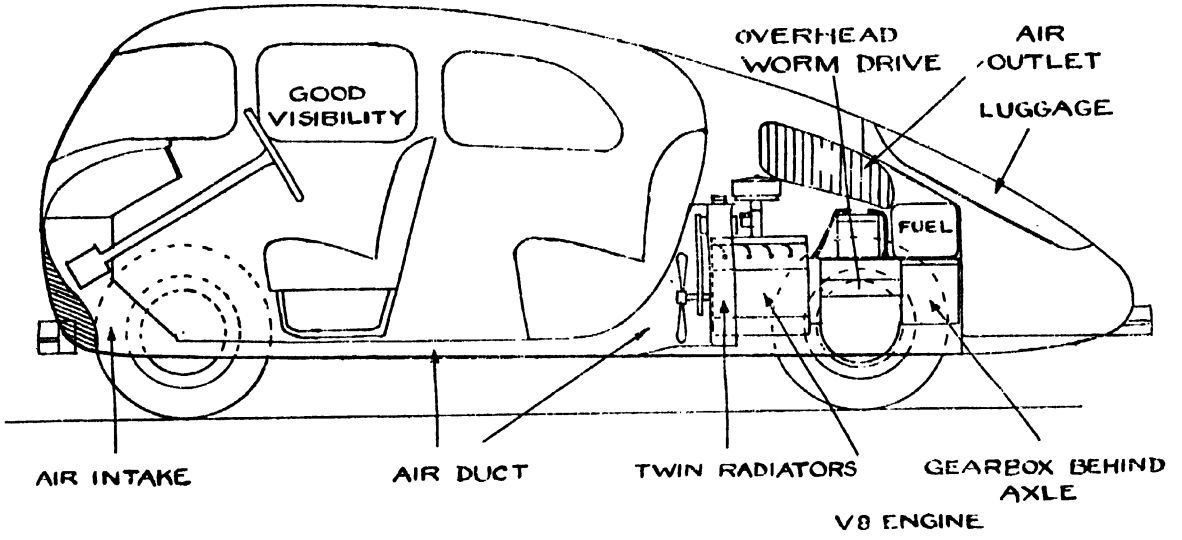


Fig. 3. The Car of Tomorrow

Figure 2 shows a popular American car of 1939 vintage. An obvious disadvantage is that the driver has an extremely poor view of the road immediately in front of the car. In a large American car tested a six foot driver could not see the road nearer than 35 feet from the front of the car at the worst position (looking over the top of the radiator). The second feature which merits consideration is the streamlining. Streamlining, to reduce air resistance, is necessary in the interests of economy at speeds above 40 m.p.h. The dotted line drawn in Fig. 2 shows the typcial streamline shape. The fit does not appear to be too bad until it is realised that a streamlined object should *travel with its blunt end forward and the tapering end to the rear.* To get the effect of the streamlining the present day car should be driven backwards! A streamlined object in reverse may have 100% greater air resistance than the same shape the right way on. An obvious suggestion which would help to convert the present day car to the correct shape would be simply to move the windscreen to the front of the car. Here unfortunately difficulties would arise. The angle of vision of the driver forwards would be very seriously reduced and the engine would become more inaccessible than it is now. The only alternative solution is to move the driver right to the front of the car where he will have uninterrupted vision forward. This will mean that he must either sit on top of the engine (using a pancake type of engine) or else the engine must go somewhere else. Fig. 3 is a possible arrangement. One advantage of the forward position of the engine is that it lends itself to a simple form of transmission to the rear wheels. The rear wheels must move up and down with every road inequality while the engine remains fixed. This with the forward engine is arranged for by having a long shaft whose small angular displacements are taken up by a universal joint or joints. In the suggested solution of this problem the engine and differential are bolted together and the movement of the rear wheels is taken up by independent springing of the axle tubes. When this change of design is carried out and the car has reached the shape shown in Fig. 3 its outward evolution will have been completed and only minor changes are then to be expected.

This evolutionary process has already taken place in the case of the aeroplane, where air resistance or drag is a much more important factor ; it is taking place in the high speed railway locomotive and is talked of for ships. The car must complete its outward evolution but how long it will take is difficult to say. When the streamline shape has arrived the consumer will be in the happy position of being able to buy a car realizing that he

is no longer at the mercy of mere changes of fashion.

Hundreds of similar and even more important questions await an answer in India. One sometimes reads articles in India emphasizing the need for academic research into the problems of 'pure' physics and chemistry. Surely in India the emphasis should first of all be on the application of science to living. The problems of the citizen in India at the moment are too urgent to be put on one side in favour of academic research. The Indian consumer has to drink impure water and adulterated milk, eat adulterated ata and ghee; he has to try and cure his diseases with adulterated drugs: to wear clothes whose colours may or may not be fast, and watch them rapidly disintigrate by primitive laundrying. With millions of horsepower of water-power running to waste and eventually flooding his home he has to cook his food on a fire of dung cakes. When he moves he has to travel over unmetalled roads in a bullock cart whose design owes nothing to scientific principles. If in a city he travels in a tonga in continuous fear of falling out at the back simply because the vehicle is not on even keel. When he shops he finds there is no universal system of weights and measures and he faces the prospect of universal education for millions of children without that boon to the child, the metric system being in use. His rupee is now only worth 6 annas and in despair he turns to our seats of learning and asks for help. Is it too much to ask for Indian scientific studies to be reoriented towards the problem of the Indian consumer instead of standing in academic remoteness?*

References

1. J. S. Huxley, Reshaping Man's Heritage, p. 94, Geo. Allen & Unwin, 1944.
2. Handbook of Chemistry and Physics, 25th Ed., p. 1432, 1941-42.
3. Health Bulletin No. 23 3rd Ed., p. 11, 1941, Govt. of India Press.
4. Health Bulletin, pp. 38-40.
5. Directions given in Health Bulletin, p. 11.
6. Kempe's Engineers' Year Book, 1940 Ed., p. 1228.
7. Forest Bulletin No. 96, Drying of Wood Fuel, 1941 graph facing p. 4.
8. Everyday Science, V. W. Haslett, p. 38.
9. Kempe, *loc. cit.*, p. 2262.
10. Prof. Thoburn, private communication.
11. A Historical Guide to Agra Fort, M. Ashraf Husain, 1937, p. 8, Govt. of India Press.
12. Lord Austin, quoted by Pitkin, A Short Introduction to the History of Human Stupidity, p. 314, Geo. Allen and Unwin.

* I am indebted to Mr Changappa and Dr Krishna of the Forest Research Institute, to Mr Hewitt of the Telephone Manufacturing Co. and to Prof. Thoburn for helpful discussions and to various Doon schoolboys whose opinions on fruit were made use of.

D. D. T. IN WAR AND PEACE

S. N. SEN

IN his general presidential address at the 32nd session of the Indian Science Congress, held at Nagpur this year, Sir S. S. Bhatnagar remarked, "The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of penicillin and D. D. T., all these have contributed much to the realization by the common man and the Government that organized science is one of the most important factors in national development." It is with the last named discovery, namely D. D. T., the new synthetic organic insecticide, that the present discussion is concerned. D. D. T. is an abbreviation of the chemical compound dichloro-diphenyl-trichloroethane, more correctly described as α''-bis-(parachlorophenyl)-$\beta\beta\beta$-trichloroethane. It is curious that D. D. T. and penicillin, the two outstanding products of war-time research and development—one an insecticide and the other a bactericide, should have so much in common. Both concern the lower forms of life; while penicillin acts upon various bacteria which cause infectious diseases, D. D. T. strikes at the very agents that serve as vehicle for a number of deadly scourges afflicting humanity. And yet, although credited largely as war-time developments, both were known several years before the outbreak of the present hostilities but remained undeveloped owing to lack of interest until fresh demands arose with war for alternative bactericides and insecticides. Furthermore, both of them, highly effective as they are against specific insects or bacteria, are remarkably non-toxic to man and animals and lend to easy and cheap manufacture.

History of D. D. T.

The compound was synthesized as early as 1874. In that year, Zeidler, a German chemist is reported to have written a paper describing the method of its synthesis from monochlorobenzene and chloral (anhydrous). Its insecticidal properties were also imperfectly known, but the intermediate nature of the compound did not for long attract the attention of the chemists and entomologists. The recrudescence of interest in D. D. T., as a possible insecticide,

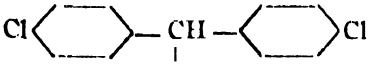
followed the investigations carried on by the research workers of the firm J. R. Geigy A. G., long interested in the problem of synthetic insecticides. In 1936-37, the research workers of the firm successfully demonstrated the insecticidal properties of D. D. T. which remained efficacious over a considerable period of time. In 1939, during an outbreak of Colorado Beetle, the potato crop pest, in Switzerland, Dr R. Wiesmann, the Swiss entomologist made field experiments with a preparation containing D. D. T. and succeeded in controlling the Colorado Beetle that season. The investigations of the Swiss workers on the insecticidal properties of D. D. T. did not at first receive much notice in Great Britain and the U. S. A. The new insecticide came to lime light only after the outbreak of the war, particularly after the entry of Japan in it, when the principal sources of supply (Japan and Malaya) of such insecticides as pyrethrum and rotenone were closed to the Allies. Since then a considerable amount of work on its chemical as well as its insecticidal properties has been done in both these countries, and D. D. T. has now been accepted as one of the most potent insecticides so far developed.

Preparation and Mode of Action

The synthesis of D. D. T., unlike its long chemical name, is a simple process. According to Zeidler, it is prepared by mixing chloral (anhydrous) with monochlorobenzene in the ratio 2 : 1 in 4-5 times its volume of concentrated sulphuric acid, and heating it in a warm water bath with occasional shaking. The reaction takes place according to the following equation :

$$2C_6H_5Cl + CCl_3CHO = (C_6H_4Cl)_2CHCCl_3 + H_2O.$$

At a temperature below 40°C, chloral has a tendency to polymerize into metachloral, a white amorphous substance insoluble in water and organic solvents, but soluble in dilute solution of sodium carbonate. Care should be taken to avoid this reaction. However, after D. D. T. has crystallized out, sulphuric acid is removed by decantation and excess of chloral is removed by treatment with water. The crystals are then dissolved in hot alcohol, to be recrystallized as a shiny cluster. Very pure D. D. T. can be prepared by subjecting it to recrystallization with alcohol for a second time. The compound thus prepared has the following structural formula :

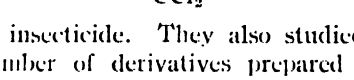


dissolves in it when hot. It is soluble in most organic solvents and also in some vegetable oils. We record below the approximate solubilities of D. D. T. in the more important solvents at ordinary temperatures.

TABLE I

Solvents	*Solubilities (in gms. per 100 gm of solvent)*
Ether	45
Benzene	106
Toluene	48
Chloroform	96
Tetrachloroethane	56
Petrol ether : 40-60° b.p.	6
,, ,, 100-120° b.p. . ..	10
Ethanol (99·5 per cent)	4
Cyclohexanol	8
n-butyl alcohol	8
tert-butyl alcohol	4
Ethyl acetate	68
Tetralin	52
Liquid paraffin	4
Orchard & spray oil	5
Kerosene (vaporizing)	11
Sextone	100

Some amount of work has recently been done with a view to correlating the insecticidal action of D. D. T. with its chemical structure. H. Martin and his co-workers, of the University of Bristol Agricultural and Horticultural Research Station, are inclined to believe, from their own investigations, that the $>CH\text{-}CCl_3$ group is probably associated with the insecticidal activity of D. D. T. When D. D. T. is treated with alcoholic alkali, it loses hydrochloric acid and passes into $\alpha\alpha$-bis(parachlorophenyl)-$\beta\beta$-dichloroethylene, but retains the other characteristics of D. D. T., as indicated in the following structural formula. Martin and his associates found that this compound was almost inactive both as contact and



stomach insecticide. They also studied the toxicity of a number of derivatives prepared by the same method as D. D. T., but none proved as effective as the original compound. These studies have led the authors to conclude that the action of D. D. T. is possibly due to its chemisorption at vital centres, interfering with essential enzyme systems. But inasmuch as D. D. T. is chemically unreactive, the alternative view of the intracellular decomposition of D. D. T. is also probable and perhaps more preferable. They are further of opinion that such decomposition results in the simultaneous production of hydrochloric acid to which the observed toxicity of D. D. T. appears to be related, as otherwise one

fails to account for the absence of toxicity of the ethylene derivative mentioned above.

Insecticidal Properties

Preparations containing D. D. T. have been marketted under various trade names, *e.g.*, Gesarol dusting powder and spray, Gesapon (an emulsion), Gesarex (a combined insecticide and fungicide), Neocid powder etc. All these preparations contain 5 per cent of D. D. T. When desired to be used as a powder for dusting purposes, it is mixed with some kind of inert carrier. An oily solution employing vegetable or mineral oil is, however, used for purposes of spraying.

A comparative study of the insecticidal properties of D. D. T. and other insecticides in use is the best way to assess the significance of D. D. T. At present, pyrethrum derived from the flowers of *Chrysanthemum cinerariifolium*, rotenone obtained from *Derris* and *Lonchocarpus* and synthetic products such as organic thiocyanates and *iso*-butyl-undecylenamide are the most important insecticides obtaining wide use. Pyrethrum differs from all insecticides in its quick knock-down action, but its action does not last long. Moreover, it proves irritant to some skins. The action of rotenone, when used as a dust, is more persistent than that of pyrethrum, and further it does not irritate the skin. But it has none of the quick knock-down action of pyrethrum. The thiocyanates and the like synthetic compounds resemble rotenone more closely than pyrethrum in their insecticidal action. The thiocyanates suffer from a persistant unpleasant odour, and these and other compounds, moreover, prove toxic to man and animals. The comparatively high cost of manufacture also militates against their wide application.

D. D. T. has all the good insecticidal properties of rotenone and other synthetic insecticides except, however, the quick knock-down action of pyrethrum, which is only characteristic of it. This lack of rapid action is more than compensated for by its remarkable persistence by virtue of which it remains toxic over an unusually long period unknown of any other insecticide so far developed. Thus the toxic effect of D. D. T. on bed-bugs was observed to persist over a period of 104 days. Flies alighting on walls sprayed with D. D. T. three weeks ago readily succumbed to it. What is more important, several launderings do not destroy the toxic action of D. D. T., and as such clothes sprayed with it remain free from body lice for a month or so and may be safely used. This keeping quality of D. D. T. has made it an invaluable addition to the list of insecticides, natural as well as synthetic

The various insects yielding to D. D. T. include house fly, mosquito, mosquito larva, flea, bed-bug, louse, honey bee, ant, cockroaches, etc. Table II records the results of two Chinese workers, Wei-Kuang Cheng and Cherng-how Lou, on the insecticidal properties of D. D. T. Sprays containing 1-3 per cent D. D. T. in kerosene and in kerosene-tung oil mixtures were prepared, as also 1-5 per cent D. D. T. dusts in kaolin, talcum, and others. The various preparations were sprayed or dusted on sheets of paper, on which the insects were separately placed and covered with a beaker. The results in the table refer to one set of tests carried out with 1 per cent D. D. T. in kaolin. It is important to note that, according to the authors, aphides (a common pest in vegetable gardening) which are readily vulnerable to rotenone and pyrethrum do not yield to D. D. T.

TABLE II

Name of insects	*Partial paralysis (time in minutes)*	*Total paralysis (time in minutes)*	*Death (time in minutes)*
House fly	6	20	150 160
Mosquito	20	60 70	170 190
Mosquito larva* ...	—		40 50
Flea	11	40 80	700 740
Bed-bug		340—380	940 980
Louse	.	160—200	820 860
Honey bee		19	110 130
Ant	8	80 90	110 130
Praying mantis ...	..	50 70	600 650
Cut Worm	Ineffective†		
Grasshopper	,,		
Aphid	,,		
Caterpiller	,,		

* Treated by spreading 1 per cent D.D.T. in kerosene-tung oil mixture on the water surface.
† Ineffective even when fed.

D. D. T. acts against these insects both as contact and as stomach poison. Lice, mosquitoes and flies are responsible for the spread of typhus, malaria, dysentery, cholera, plague, enteric fever, etc. D. D. T. thus fights the menace of these diseases by striking at these insect agents. Here we shall briefly describe the effect of D. D. T. against body lice which transmit *Rickettsia prowazeki*, the cause of epidemic typhus. The best method of controlling typhus is, therefore, to attack the lice, for 'no lice, no typhus', as the old epidemiological, but still applicable, rule goes. Prior to the discovery of D. D. T., a number of insecticides effective against lice were available. Thus, an insecticide called AL 63, developed in Britain, protected persons from lice for 5-6 days. The U. S. Bureau of Entomology and Plant Quarantine recommended a dust, called MYL, produced in the U. S. A. Russian chemists were also not slow in this matter; they developed two synthetic compounds, diphenylamine and *bis*-ethyl-xanthogen, which were tried on Russian armed forces

as well as on civilians with varying degrees of success. After the discovery of D. D. T., it has been the insecticide of choice against lice. The work of P. N. Anand and his workers indicate that D. D. T. is more effective and persistent in its action than any delousing agent hitherto tried. It protects grossly infested persons against lice for two to three weeks and gives an effective control for a longer period. It may be mixed with kaolin or pyrophyllite to produce a powder that may be blown up the sleeves or down the necks of dressed persons. Another method of using D. D. T. consists in dipping undergarments in a solution of D. D. T. in volatile solvents and in an aqueous emulsion of the same. Delousing effect of such garments continues from 3 to 8 weeks or more, depending on the concentration of the solution, and even 9 weekly washings have not impaired the toxic effect of D. D. T. The way in which this insecticide has helped to arrest the spread of typhus and other diseases in this war will appear in what follows. As to its peace time uses which are likely to be varied and multiple, we shall have to wait till the return of peace.

The possibility of its use in industry has been indicated recently by the investigations of G. A. Campbell, of Geigy Colour Co. Ltd., and T. F. West, of Stafford Allen and Sons Ltd., on the persistence of D. D. T. in oil-bound water-paint. They have shown that oil-bound water-paint incorporated with D. D. T. is effective against house flies and that the paint does not lose its insecticidal properties even after two months. Small rooms painted with oil-bound water-paint containing D. D. T. readily become relieved of flies, and good results have already been obtained by employing such paint in factory canteen.

D. D. T. IN THIS WAR

At present the whole of D. D. T. is allocated for use in the armed forces. Small quantities are, however, available for purposes of laboratory investigations. The story of its entry in this war on the Allied side has it that in 1942 the J. R. Geigy Company drew the attention of the British Legation to the importance of D. D. T. on which they had already made satisfactory trials. The British Geigy Company in Manchester brought the compound to the notice of the authorities in Britain, and immediately the Government organized a team of workers from Government laboratories, the universities, and the industries to undertake the investigation and arrange for pilot-plant experiments. The results were highly satisfactory, and the product was recommended for use in the Army. In U. S. A., the experience of the Geigy firm was communicated to the U. S. Department of Agriculture. The chemists of the Bureau of Entomology and Plant Quarantine soon analyzed the compound and confirmed the remarkable insecticidal properties claimed for D. D. T.

During January, 1944, D. D. T. made medical history by successfully bringing under control an outbreak of typhus in epidemic form in Italy. 1,300,000 civilians were dusted with D. D. T. powder, and further spread was arrested. 'This is the first occasion in medical science when a typhus outbreak has been arrested in mid-winter'. The significance of this success will clearly follow from the fact that typhus killed about 10,000 people in 6 months in Serbia during the World War I and some 3 million Russians after the Revolution. The typhus epidemic is a common aftermath of war, famine and the like national catastrophies and finds a fertile field among the starved and devitalized population.

The great demand for D. D. T. for armed forces will be realized from the fact that last year output of D. D. T. in the United States was 300,000 lb. per month. Her present production is reported to have exceeded a million.

CONCLUSION

The lay press have waxed eloquent on the startling insecticidal properties of D. D. T. as a reaction to the first impulse of a new discovery. In some quarters, it has even been suggested that it will soon replace all other insecticides. Remarkable indeed as the properties of D. D. T. are, it will be sober to describe it as 'one of the more promising synthetic organics', as one writer has stated. Under the stress of war, D. D. T. received far more organized and elaborate tests than did other insecticides whose sources are now controlled by Japan. It is improbable that the popularity of pyrethrum, for instance, as an effective controlling agent of flies and mosquitoes will suffer on the score of D. D. T. In an all-out drive against insect pests which at present constitute a standing menace to life and agriculture, the various insecticides will have their place in varying degrees of importance, and the success attending the investigation on D. D. T. should serve as a stimulant to further research in this important branch of applied entomology.

References

Ziedler, O., *Deutch. Chem. Gesell.*, *7*, 1180, 1874.
Campbell, G. A. and West, T. F., *The Chemical Age*, Sept. 9, 1944; *Nature*, *154*, 3912, 1944.
Wei-Kuang Cheng and Cherng-how Lou, *Biochemical Bulletin*, *44*, October 1, 1944.
Munro, J. W., *Nature*, *154*, 3907, 1944.
Lapage, G., *Nature*, *154*, 3915, 1944.

INDIAN SCIENTISTS ON THEIR VISIT TO THE U. K. & THE U. S. A.

FIVE members of the Indian Scientific Mission, who have just returned to Indian from their tour in the United Kingdom, the United States and Canada, have issued a joint statement to the Press, the full text of which runs as follows:

"Five members of the Indian Scientific Mission, Sir S. S. Bhatnagar, Sir J. C. Ghosh, Prof. S. K. Mitra, Prof. J. N. Mukherjee and Prof. M. N. Saha returned to India on February 19th, after about five months stay in the United Kingdom and the United States of America and Canada. Two members of the Mission, Dr Nazir Ahmad and Col. S. L. Bhatia will return later.

"The Mission were the guests of His Majesty's Government in the U. K. Excellent arrangements for their tour were made by the Royal Society of London and several other organizations. In the U. S. A. the party were the guests of the State Department for a short time after their arrival. An Officer of the State Department was deputed to help the Mission in their tour.

"The principal object of the party was to see for themselves how scientific and technical research has been applied in recent years to the development of natural resources and for economic betterment of the people of these progressive countries and to recommend suitable measures for India.

"In the U. K. the Mission visited the more important research institutions of all types *e.g.*, universities, research establishments maintained by industries, official and non-official research organizations, war production centres, agricultural research stations and also several special research stations brought into being to aid the war effort. They also contacted eminent men of science, technological experts, prominent industrialists and prominent public men.

"The Government and the public in these countries have, under the menace of Fascism, realized, as never before, the social and political implications of science. The Mission have been impressed by the total mobilization of scientific talent for the prosecution of war. The effort being made there has already effected vast changes in industrial efficiency and has been mainly responsible for the defeat of Fascism and has revealed that when the people and the Government are enthused with a common purpose, industrial and agricultural exploitation of resources offered by nature can effect wonders in peace as well during a war. The party is convinced that scientific exploitation of the natural resources of India can afford solution to her problems of poverty, malnutrition, disease and ignorance and restore her once more to her rightful place in the comity of nations. India has the brain power and the population to achieve all this. But her progress in these directions must be by forced marches, and there must be a national purpose behind all her plans of development so that the people may be enthused and put their best effort and support the Government to the fullest extent in their effort for an all round industrial and agricultural development.

"We were rather surprised to learn that even though there was a desire in some quarters in the U. K. to have important operational research and research for development of war weapons carried out in India, as has been done in Canada, this policy was not adopted in India. Only some problems of supply and substitutes were assigned to the Council of Scientific and Industrial Research and the Supply Development Committee. If Indian scientific men had been given an opportunity to help in this matter, there is no doubt that very fine results would have accrued.

"For the success of any plan for the economic development of India, the first requisite is the creation of the necessary technical personnel. They are the key men and their training should be taken in hand well in advance. From the assurances we have received, and the contacts we have made we feel that there will be no difficulty in providing such training in these countries in sufficiently large numbers. Accordingly the Mission will recommend to the Government of India that immediate steps should be taken to open scientific offices in London and Washington for arranging the training, and to act as a clearing house for information. We hope that both Industry and Government in India will immediately formulate a comprehensive programme which will indicate their requirements of such technical personnel in the next five years.

"It will, however, be unwise to depend on foreign countries for long for the training of technologists. We feel that our own institutions should, in the course of the next five years, be able to offer to our young men the same facilities for training and research as are available in U. K. and U. S. A. The Mission, accordingly, will recommend to the Government that generous financial provision be made to raise the standards of, and widen the scope of, our existing institutions and also bring into existence fresh institutions as are necessary.

"The industrialists and businessmen of these countries are now convinced that no industry which had its root on scientific knowledge can prosper in a competitive world unless continually improved

upon by new inventions based on scientific research. They also recognize that the power that industry derives from new scientific knowledge comes from its early use and from contact with scientific men who created such knowledge. It is not surprising, therefore, that all the industrial establishments which we visited organized magnificently equipped research laboratories of their own, and their expenditure on research ran into millions of dollars. Hundreds of science graduates are working in each of these research laboratories. We found that such establishments generally pay very handsome dividends. We also found that not only such research laboratories were in charge of eminent scientific men, but often the key positions in the management of the large industrial concerns were held by men who started life as technical men.

"We could do but little justice in the way of acquainting ourselves with the numerous and unique industrial and scientific organizations in the U. S. A. in eight weeks. We were able to visit the Tennessee Valley which has won world-wide recognition as a model of successful regional planning. We also visited laboratories of the Gulf Research and Development Company of Pittsburgh, the Radio Corporation of America, the Bell Telephone Laboratories, the Mellon and Batelle Research Institutions, American Cyanamide and Chemical Corporation, and many others, which are models of private enterprise, each spending several million dollars per year in research alone. Researches in connection with the war effort are being carried out on a vast scale in the universities and other research institutions under the auspices of the O.S.R.D. (Office of the Scientific Research & Development)—a Government organization created during the war, and disbursing nearly 6000 million dollars for research and development. We understand that this organization will be retained under a different name even after the termination of the war, the object being to exploit as quickly as possible scientific discoveries.

"We have observed that discoveries of great industrial importance have been made in many fields *e.g.*, plastics, radio, etc. After the termination of hostilities, all these inventions will be exploited for peace time industries and the products let loose on the open market. They will have a revolutionary effect on chemical, electrical, mineral, mechanical and drug industries of which our Government and industries should take timely notice.

"America has been using, to a far greater extent than is generally known, geophysical methods of prospecting for finding out deposits of oil and valuable ores. Such methods have been responsible for the discovery of some of the biggest oilfields in Western Asia, and valuable ores under the snow covered fields of Canada.

"In Canada we acquainted ourselves with the work of the Canadian National Research Council and the Canadian Research Enterprises Limited. The former is a body created after the last war but functioning energetically only after 1939 and corresponds to our Council of Scientific and Industrial Research. It has rendered invaluable service to the cause of development of radiolocator (Radar) technique and other war research. The Canadian Research Enterprises was brought into existence in September 1939, with a view to mass scale production of optical glass, optical instruments, and instruments required for Radar and its annual outturn now amounts to 8 million dollars. All this has been achieved in an incredibly short time in a country which had neither the equipment nor the requisite technical knowledge. Canada has as it were jumped off 25 years in the course of 12 months which is the interval between which the first sod was turned and the first optical glass came out of the works. The history and performance of the National Enterprises Limited have convinced us that provided there is good will, understanding and the spirit of co-operation and long years of industrial apprenticeship, unpreparedness can be compressed into very much shorter period.

"The United States are very sympathetic towards the question of full industrial development of China. Large parties of Chinese are now receiving higher training in the U. S. A. at the expense of the Federal Government. In the Massachusetts Institute of Technology alone, we were informed, nearly a hundred Chinese students are being trained in all branches of technology. We came across a party of 33 Chinese engineers in the Niagara Falls, who informed us of a single hydro-electric project at Ichang on the Yangtse River which is expected to yield as much electrical energy as is now developed in the whole of U. S. A. from hydro-electric sources (nearly 1,00,000 million units). The industrialization of China on such a vast scale will have far reaching effect on the Indian economy, and this should engage the serious attention of the Indian public and the Government.

"In the matter of food production, the achievements in the United Kingdom and the U. S. A. have been most excellent. In the United Kingdom food production has been increased by about 60%. Agricultural researches and soil conservation measures are going on full speed ahead. The utilization of raw materials produced by agriculture is receiving organized attention by scientific workers. In the U. S. A. the four regional laboratories which are devoted to this purpose are splendidly equipped and on a scale which has been a matter of considerable surprise. A modern State has to deal with problems of land utilization in its various aspects such as location of industries, sites for town planning, pre-

servation of wild life and natural scenery and recreation centres and the rival demands on the land. Both in the United Kingdom and the United States, these problems are being dealt with by different Government departments, and the tendency seems to be to secure a balanced development of the land resources of the country.

"These countries have made great progress in surveying natural resources of mineral, vegetable and animal origin, and the lesson for us is that simultaneously with plans of development, wide scale surveys of various types should be taken in hand.

"It is our considered opinion that no much good will come out of the polemical discussions about the relative merits of private enterprise *versus* State management of industry and agriculture. We believe that every party should do its part. Scientists are always willing to help anybody who is ready to shoulder this responsibility. For developing India we must use to the fullest extent her natural resources, and for this purpose there should be a National Government at the centre as well as in the provinces. This view was advocated by all of us in course of our lectures and conversations in the U. K., and we were happy to find that most of the scientists, administrators and industrialists fully endorsed this view. Mr Amery and other Cabinet members told us repeatedly that India now enjoys the fullest freedom regarding her economic development and if she fails to take any effective measures in this direction the responsibility rests solely with the members of the Government of India.

"Two of our colleagues are not with us at present, but we have reason to believe that they will endorse the above statement."

Notes and News

AN INTERNATIONAL SCIENCE CO-OPERATION SERVICE

In an able article in *Nature*, November 25, 1944, Dr Joseph Needham who is now in charge of the Scientific Co-operation Office of the British Council in China has made out a case for the creation of an international science co-operation service, which deserves the closest attention of those desiring to see free scientific intercourse established across national frontiers when peace comes. This war has brought into existence, as an emergency measure, a number of scientific co-operation offices such as the British Central Scientific Office in Washington, the American Scientific Office in London, the Anglo-Soviet Science Collaboration Committee, and the Scientific Co-operation Office of the British Council in China, which, by mobilizing important scientific information among the United Nations, have played, and are still playing, a significant role in the successful prosecution of the war. Similar scientific organizations were also created during the war of 1914-18 but were allowed to disappear with the conclusion of the war without giving much thought to them. It seems unlikely that this time too the science co-operation offices which are widely believed to exert an equally profound influence in solving the problems of peace will meet a similar fate. "We see every where", Dr Needham remarks, "a growing conviction that after the war a much higher degree of international science co-operation must be attained. There are many who believe that the time has gone by when enough can be done by men of science working as individuals or even in groups organized in universities or societies, within individual countries, and contacting each other as individuals, across national boundaries. Science and technology are now playing, and will in the future increasingly play, so predominant a part in all human civilization, that some means whereby science can effectually transcend national boundaries is urgently necessary". In his opinion, an international science co-operation service having representatives to be drawn from both government and academic laboratories and entitled to the same diplomatic status as accorded formerly to League of Nations officials and to guaranteed Government facilities for communication and transport is best calculated to fulfil this purpose. Dr Needham defines the character and functions of such an organization in the following terms:

(1) That an International Science Co-operation Service should be set up by the United Nations at the conclusion of the War under the aegis of whatever supreme international organization is devised, parallel with the International Labour Office, the International (Permanent) Commission on Food and Agriculture, and other similar bodies.

(2) That the functions of the International Science Co-operation Service should be (*a*) the promotion of scientific co-operation in all its aspects, (*b*) the collection and dissemination of scientific information, (*c*) the furtherance of schemes of collaboration in research, (*d*) the facilitation of the movement of scientific men across national boundaries, (*e*) the provision of advice on scientific matters to

government and diplomatic personnel of individual States when desired, (f) the provision of scientific assistance to all other international organizations.

(3) That the International Science Co-operation Service be supported by funds, which relatively to those required for other purposes would, of course, be small, subscribed by the Governments of the United Nations on some agreed income-tax basis.

(4) That the International Science Co-operation Service should have permanent representatives in all countries or regions, with diplomatic or 'League official' status, and guaranteed Governmental facilities for communication and transportation.

(5) That the International Science Co-operation Service should have permanent headquarters in some centre to be later decided on; but that apart from a central and peripheral permanent secretariat, a considerable proportion of the total number of its officials should be working scientists of every nationality serving on a temporary leave-of-absence basis, that is, seconded from governmental, academic and possibly industrial, laboratories; in order to ensure that the organization shall always preserve the true atmosphere and understanding of research.

We cordially welcome Dr Needham's proposal for the establishment of an international science co-operation service in the post-war period. That there exists today a clear need of the promotion of all aspects of scientific co-operation, including collection and dissemination of scientific information, collaboration of research, the facilitation of the movement of scientific men across national frontiers and the like, is admitted on all hands. He has not, however, made clear how this organization will be evolved out of the existing scientific collaboration offices which are at present mainly concerned with the prosecution of the war. We hope that this and other questions relating to details, likely to be raised, will be clarified in the process of discussion which Dr Needham's memorandum is certain to stimulate.

A NATIONAL INSTITUTE OF ECONOMIC RESEARCH

In his inaugural address at the 27th session of the Indian Economic Conference held in Delhi on December 30, 1944, the Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, revealed that the Government were contemplating to establish a National Institute of Economic Research. The Institute which will be located in Delhi will be an autonomous body mainly non-official in its composition and management. The Government will, however, provide the necessary fund to be utilized for carrying out systematic, scientific and impartial research surveys into various problems bearing on the task of planning and economic development of India.

An institute of economic research is a prerequisite for successful planning for the economic development of a country, and it is gratifying to see that the Government are aware of it and are thinking to take necessary steps in that direction. As Sir Ardeshir rightly said, a great deal of research work will have to be undertaken into the various aspects of the country's economic life, not only for facilitating the formulation of proposals for planning, but also for watching the progress and for making readjustments from time to time to ensure the success of the plan. The facilities which such an institute will provide, coupled with the analytical judgment of the professional economists, will be of the greatest value now that the Government have embarked on a planned economic development.

In this connection Sir Ardeshir also referred to the poor statistical data, often of doubtful accuracy, in which again large gaps exist. This inadequacy in statistical information constitutes a real stumbling block in the way of planning, as we have often emphasized. We learn that a closer association with the Indian Statistical Institute is being considered by the Government.

FERTILIZER PLANT NEAR DHANBAD

The news of the Government decision to establish a synthetic fertilizer factory at Sindri, near Dhanbad in Bihar, for manufacturing 3,50,000 tons of ammonium sulphate per annum has already appeared in the press. In an earlier issue, we reported the recommendations of the Technical Mission headed by Mr G. S. Gowing, which favoured the establishment of a single plant at Harduagunj near Aligarh. A heated controversy, both in official as well as in non-official quarters, followed the submission, by the Mission, of the report, and the press, the industry, and the experts were almost unanimous in their opposition to their recommendation in favour of Aligarh as the most suitable site for economic production in preference to the coal-producing areas of Bihar and Bengal. It is indeed gratifying that wiser counsels have at last prevailed with the Government who have now been convinced that Sindri in Bihar, by virtue of its proximity to the coal deposits, has greater potential advantages than the site recommended by the Mission. It further holds out the possibility of developing subsidiary industries from nitrogenous products. The Government are also investigating the prospects of erecting another unit having the capacity of 1,00,000 tons per annum on a site somewhere south of the Vindhyas.

The factory at Sindri should be State-owned and State-controlled, as the Government have suggested. The Central Government will undertake the management of the factory. The relation that should exist between the States and the provincial Governments in the scheme is now under consideration.

The rejection of the Mission's recommendation concerning the most vital question of location of the factory confirms the misgivings which we entertained from the very outset regarding the technical competence of the experts constituting the Mission. The

Mission toured throughout India for about two months visiting industrial and economically important areas, and all available facilities and information were placed at their disposal. They finally produced a report on whose recommendations even the Government, always encouraging foreign technical mission whenever any development is projected, failed to act. And this, after public money has been lavishly expended to bear the cost of the Mission! More such tragedies are in store for us until the Government learn to abandon the thoughtless practice of inviting foreign missions and rely on Indian experts who, if required, may be sent abroad for expert advice, experience and training—a practice which is universally followed in all free countries enjoying national governments.

THE RUBBER INDUSTRY IN INDIA

THIS is the title of a monograph by Prof. N. N. Godbole, recently issued by the All-India Manufacturers' Organization, Bombay. The monograph briefly traces the development of the rubber industry in India and also discusses its chemistry and technology. The introduction of the rubber plantation in this country has an interestnig history. Sir Henry Wickham smuggled the precious seeds of *Hevea brasillienses* out of Brazil, the natural habitat of this most important species of the rubber plant. The seeds arrived at Kew in 1876, where they were planted, and the seedlings were later distributed to India, Ceylon, Malay, Java and other parts of the East. In India, the cultivation of the *Hevea* plant started rather late compared to other parts of the East. Travancore State, with its multiple plantations in the Shencottah, Mundakayalam and Rani Valley districts in the Western Ghats, has now become the leading rubber producing centre in the whole of India and accounts for about 80 per cent of the Indian crop. The total area under rubber cultivation stood at 1,36,614 acres by the end of 1941, and in 1942, the total production was about 17,000 tons. According to an estimate carried out in 1943, there are 114 rubber factories in India, using both rubber latex and para rubber. Rubber trade of India, comprising both export and import, accounted for Rs. 382 crores in 1930-40 and Rs. 360 crores in 1940-41.

An intensification in the production of rubber in India followed the Japanese occupation of Malaya, the Netherland East Indies and other important rubber growing areas of South-East Asia, when a supply about nine-tenths of the world output was lost to the Allies. India could have increased her acreage under rubber and indicated a far greater annual output, but for the rubber cartel known as the International Rubber Regulation Committee constituted in 1934. The rubber cartel controlled largely by the combined U. S., British and Dutch interests led to the impregnable South-East Asian monopoly. This was one reason of the great development in the production of synthetic rubber in Germany and the Soviet Union before the war.

CULTURAL CO-OPERATION

THE U. S. Department of State has issued a report, by H. Hanson, containing the activities of the Division of Cultural Relations since its inception in 1938. The scope of the cultural co-operation programme, as envisaged by the General Advisory Committee of the Division of Cultural Relations, is intended to be a long term one and includes vigorous development of cultural relations between the people of the United States and other free peoples of the world on a basis of mutual understanding and appreciation and inter-changes in all fields of the arts, sciences, technology, letters, and education, and throughout the entire range of economic and social life. In fact, the programme is intended to be as broad as intellectual and cultural activities themselves.

When the Division was established in the Department of State in 1938, its activities were confined mainly within the Western Hemisphere. During the period 1938-41, its programme was guided by one aim, namely, the promotion of inter American unity, necessitated largely by Axis expansion in Europe. The extension of its sphere of activities outside the Americans took place with the inclusion of China in 1941 within its cultural co operation programme. The China programme began to operate from January, 1942, with an allocation from the Emergency Fund for the President and revolved around four principal activities: the sending of American technical experts requested by Chinese Governments, exchange of professors, the awarding of study grants to Chinese students in the United States, and the sending in microfilm of technical and scholarly journals requested by Chinese universities. Since 1943, the Division steadily extended its activities to the countries of the Near East and included Turkey, Syria, Liberia, Egypt, Iran, Ethiopia, Morocco, Spain, Sweden, Soviet Russia and others. The nature of this co-operation has been different in different countries.

Up to the close of 1943, the Congress had made appropriation to the Department of State only for the programme with the other American republics only. The programme in countries outside the Western Hemisphere was financed from the Emergency Fund for the President. The total funds available for this purpose during the period 1940-44 are as follows: 1940-41, Hemisphere only, $1,09,000;

1941-42, Hemisphere and China, $3,47,000 ; 1942-43, Hemisphere and China, $1,234,000 ; 1943-44, Hemisphere, China and Near East, $2,871,000.

A statement of policy on the participation of the United States in the educational and cultural rebuilding of Europe indicates the Department's concern in the educational rehabilitation work after the war. The programme which the Department now has in view may consist of (1) assistance in the restocking of essential educational facilities, especially with books and scientific and other teaching aids, (2) assistance in providing opportunities for the training of carefully selected foreign students in American institutions, (3) assistance in re-establishing essential library facilities, etc. The report further includes notes on professional and scientific relations, and on various activities under the programme.

PROF. R. A. FISHER IN INDIA

Our readers will be interested to learn that Prof. R. A. Fisher, Balfour Professor of Genetics, Cambridge University, came out to India on January 24 as the visiting Professor of the Indian Statistical Institute, Calcutta. While at Calcutta, Prof. Fisher delivered six lectures on Genetics at the Institute and visited a large number of scientific institutions, including the Bose Institute, the All-India Institute of Hygiene and Public Health, and the Indian Association for the Cultivation of Science. Prof. Fisher's consultative services, it is understood, are being utilized by the Government of Bengal and the Central Government in the Departments of Agriculture, Civil Supplies, Irrigation, Commerce, Industries and Labour, and Finance. He will leave for England by air on March 10.

An eminent statistician of the present time, Prof. Fisher was Head of the Department of Statistics of the Rothamsted Agricultural Institute from 1918 to 1933. He succeeded Karl Pearson as Galton Professor in the London University and in 1943 accepted the Balfour Professorship of the Cambridge University.

SCIENTIFIC CONSULTATIVE COMMITTEE

The Government of India have constituted a Scientific Consultative Committee consisting of official and non-official members, which will advise the Government on all general questions of policy relating to research throughout India and on any special matters concerning research that may be specially referred to it. The Hon'ble Member for Planning and Development is the Chairman of the Committee which include the following members ; *Officials*—The Master General of the Ordnance, the Vice-Chairman of the Imperial Council of Agricultural Research or the Agricultural Commissioner to the Government of India, the Director General, I.M.S., the Director, Geological Survey, the Director, Scientific and Industrial Research. *Non-officials* — Sir C. V. Raman, Sir J. C. Ghosh, Prof. M. N. Saha, Dr Nazir Ahmad, Col. Sir R. N. Chopra.

CHEMISTRY IN THE SERVICE OF MAN

In an address on the above subject recently delivered before the Royal Society of Arts, Dr E. F. Armstrong, F.R.S., has discussed how chemistry not only tells all about natural substances but also enables us to make new products rivalling the natural products in utility. He describes how knowledge of chemistry is helping the cheap production of edible proteins, which is of great interest in view of the present world shortage of proteins. According to Dr Armstrong, each protein is made up of a large number of molecules of amino acids, of which there are twenty different kinds. The protein molecules are very large, containing a thousand or more amino acid molecules, and they differ in the percentage of amino acids present. The individual amino acids are joined end to end in a chain, the exact pattern of which has not yet been established for any protein.

The body breaks down the protein it eats into individual amino acids and uses them again to make its own protein ; hence the importance of each amino acid. Men and animals need most of them. Probably meat is so important a food because it contains those very amino acids which we require to make muscle tissue. Our main source of protein is meat from animals, which converts vegetable proteins in herbage into beef, mutton and pork ; the process is a slow one. Another source is the pulses, seeds of high protein content etc. which can be improved by selection and cultivation. Another source is fish. The wide-spread cultivation of the soya bean is a notable example of progress in protein production. Unfortunately, this vegetable protein only ranks as second class. Considerable interest, therefore, is attached to the production of protein in the form of yeast, which can be multiplied very rapidly in the course of a few hours. Whereas animals make their protein from the small amount of organic vegetable protein in the very large quantities of herbage they consume, the yeast can make its own protein with the help of carbohydrates of vegetable origin and of ammonium salts which are inorganic and manufactured from nitrogen in the air. The technical question becomes whether yeast can be made in large quantity from carbohydrate and inorganic nitrogen at a competitive price with meat. In-

organic nitrogen, a product of high pressure technique, is very cheap today and is available in unlimited quantity. It is claimed that the yield of protein per acre in the form of yeast made from molasses calculated from the area of land required for production of molasses is several times greater than that of protein grown as soya beans which have a high protein content. It is also much higher per acre than that obtained by feeding fodder crops to animals. Beef protein needs not only a large acreage on the other hand, but takes a much longer time, about year or more ; yeast protein is a matter of twenty-four hours.

A specially suitable race of yeast (Torula utilis) for the purpose has recently been developed in London, and factories are understood to be under construction to make it in Jamaica and Mauritius, where its first use will be for the under nourished children in those colonies. In the tropics protein scarcity is often severe, but waste carbohydrates are plentiful. Certain races of yeast multiply so rapidly that alcoholic fermentation is practically negligible. The yield of dried yeast in practice is 60 per cent of the fermentable sugar. Another source of carbohydrate is the waste sulphite liquor of paper mills from which according to a calculation made in Germany 1,00,000 tons of dry yeast a year equivalent to 50,000 tons of protein can be made. A development which is not very far remote is the making of fermentable carbohydrates from wood. By what is known as the schollar process wood in the presence of dilute sulphuric acid at a pressure of 4 atmospheres, the temperatures being taken up to 190°C, is converted into easily fermentable glucose. At present in the United States it is calculated that about 1,00,000 tons of Baker's yeast has been produced in 1944, about half of which is protein. The vitamin content of this yeast is not high, but it will be possible to enhance it by changing the nutrient. Brewer's yeast is essentially a byproduct of the fermentation of beer, more than 12,000 tons are available as a sherry, of which one-third is recovered as cattle food, and about one-tenth used as food or sold in the pharmacy. The vitamin content is some three times as great as that of baker's yeast. This yeast is now grown as food, without using hope, so that the product need not be delittered. The dried yeast has a high vitamin content of vitamin B complex and retails at 3s. per pound and contains 46 per cent of protein. Beef with 10 per cent of protein sells at 2s. per pound. The lecturer remarked how within one generation Britain and the United States have passed from the stage in which most of this food supplies went directly from the farm to the consumer, to the present development in which the food industry processes distribute a large and growing part of the total food supply.

PHARMACOGNOSY IN INDIA AND ITS FUTURE

A SCHEME for post-war development of drug industry in India and the role of botanists in the study of pharmacognosy was put forward by Mr S. N. Bal, in his presidential address entitled "Scope of Pharmacognosy in India and its Future" at the 9th Annual General Meeting of the Botanical Society of Bengal, held at the Botanical Laboratory, Calcutta University, on February 18, 1945.

It is high time that the botanists should seriously take up the study of pharmacognosy in all its aspects, *viz.*, proper identification, distribution, anatomy, pathology, etc., of plants, and it is only by the collaboration of the botanists, chemists and medical men that India can be independent of her drug requirements.

India is very rich in her drug resources comprising about 2,500 medicinal plants including 300 mentioned in the British Pharmacopoeia and British Pharmaceutical Codex. Fifty per cent of B. P. and B. P. C. plants are found in India, and as this country possesses all sorts of climate and soils, there is great potentiality of introducing new plants. When all the branches of pharmacognostic studies are pursued in India, it will lead to the production of standard products of requisite potency, which will be accepted throughout the world.

Potency of many vegetable drugs in India has already been well recognized, but we have not as yet any book on 'Indian Pharmacopoeia', with the consequence that we have to fall back on British Pharmacopoeia as our standard in spite of the fact that the standards prescribed for England may not be suitable in India. "We ought to have a national pharmacopoeia of our own which could fulfil all our requirements by solving the various pharmacognostic problems and by incorporating in it such indigenous drugs which have been scientifically and pharmocognostically investigated. The needs for such a work has been recently realized by the Government of India who have undertaken the preparation of an Indian supplement to the British Pharmacopoeia".

In tracing the history of development of pharmacognostic studies, Mr Bal went on to say that the cultivation of medicinal plants can be traced to 2000 B.C. when the Babylonian kings encouraged culture of medicinal plants. In India, earliest mention of the cultivation of drug plants is mentioned in the treatises of *Charaka* and *Susruta*.

During the middle ages, culture of medicinal plants was confined to monasteries, and later a number of *herb gardens* were started with the establishment of universities, earliest of these being the Padua Herb garden founded in 1533 A.D. Modern pharmacognosy really developed during the 19th and

20th centuries, that has led to the development of histological and chemical pharmacognosy.

Large scale cultivation of medicinal plants except cinchona and ipecac, however, is still unknown in India, and the authorities still appear unperturbed by the fact that thousands of people have died in recent years due to 'drug famine'.

While researches are being undertaken in India on the chemical aspects of the drug plants in the School of Tropical Medicine, Biochemical Standardization Laboratory and the University College of Science, Calcutta, such researches should go hand in hand with researches in pharmacognostic line.'

The following were elected to the various offices of the Botanical Society of Bengal for the year 1945-46. *President*: Prof. S. R. Bose; *Vice-Presidents*: Prof. S. P. Agharkar, Mr S. N. Bal (*Ex-officio*), Mr I. Banerji Dr K. P. Biswas, Prof. G. P. Mazumdar; *Honorary Treasurer*: Mr J. C. Banerji; *Members*: Prof. K. G. Banerji, Mr E. A. R. Banerji, Mr A. K. Chakravorty, Prof. A. C. Datta, Mr A. K. Ghosh, Dr K. T. Jacob, Mr P. N. Nandi, Prof. J. C. Sen Gupta, Dr S. R. Sen Gupta; *Honorary Secretaries*: Dr P. N. Bhaduri, Dr J. K. Chowdhury.

ROYAL ASIATIC SOCIETY OF BENGAL

The 161st Annual Meeting of the Royal Asiatic Society of Bengal was held in the Society's rooms on February 5, 1945. His Excellency Mr R. G. Casey, Patron of the Society presided.

Presenting the annual report, the General Secretary (Dr Kalidas Nag) referred to the task of reorganization of the Society. During the year under review the Society made a number of proposals in connection with the post-war scientific, industrial and cultural reconstruction of India. The latter deals with such problems as the establishment of (1) a traveller's department in India, (2) a central record office in Bengal, (3) a national museum at New Delhi, (4) a school of Indian architecture and planning, (5) a national cultural trust, (6) a national academy of arts and letters, (7) national parks, and also (8) the future of the archaeological department.

Referring to these proposals for the cultural reconstruction in India, that so vitally concern the country's future welfare and progress, Dr S. P. Mookerjee, the retiring President said, "Our proposals form the basis for fruitful discussion and will serve to stimulate public opinion. The ideals and aspirations of a nation are best represented by its culture. India, in spite its having a variety in languages, religions and physical types, has a basic national culture."

His Excellency Mr R. G. Casey, addressing the Society, emphasized the part that a learned body like the Royal Asiatic Society of Bengal can play in the application of modern scientific research to the "old arts of agriculture and industry".

"I am encouraged to speak to you of these scientific matters by reason of the terms of encomium in which Prof. A. V. Hill has written of this Society in a recent report on scientific research in India."

His Excellency congratulated the retiring president on the successful activities of the Society during the year and welcomed the new president, Dr Meghnad Saha, whose election, he hoped, 'may be said to portend closer integration of science and culture, which is of very great importance to the future development of human civilization'.

The following awards of the Society's medals and prizes for 1944 were announced:

Jay Gobind Law medal to Rai Bahadur Dr S. L. Hora, D.Sc., F.N.I., Director of Fisheries, Bengal, in recognition of his conspicuously important contributions to our knowledge of ichthyology of Asia. Paul Johannes Brühl medal to Dr N. L. Bor, D.Sc., F.N.I., Chief Refugee Administrator, Burma Refugee (Formerly Forest Botanist, Imperial Forest Research Institute, Dehra Dun), for his important piece of original research in the gramineae and the ecology of Indian plants.

Dr Bimala Charan Law medal to Dr D. R. Bhandarkar, Ph.D., formerly Professor of Ancient Indian History and Culture, Calcutta University, for his conspicuously important contributions to ancient Indian history and culture.

Sarat Chandra Roy medal to Dr Verrier Elwin, D.Sc., F.N.I., of the Bhumijan Sevamandal, Patangarh, C. P., for his meritorious and many-sided contributions to the study of cultural anthropology of India.

Elliot Prize to Dr S. K. Chakrabarty, D.Sc. of the University College of Science and Technology, Calcutta for his contributions to mathematics.

Dr P. C. Bagchi, M.A., Dr es letters (Paris) was elected an Ordinary Fellow of the Society.

The following were duly elected as members of the Council for 1945:

President: Dr Meghnad Saha, D.Sc., F.N.I., F.R.S., F.R.A.S.B.; *Vice-Presidents*: the Hon'ble Mr Justice N. G. A. Edgeley, M.A., I.C.S., Barrister-at-Law, Dr R. C. Mazumdar, M.A., Ph.D., F.R.A.S.B., Dr M. Z. Siddiqui, M.A., B.L., Ph.D., Dr S. P. Agharkar, M.A., Ph.D., F.N.I.; *General Secretary*: Dr Kalidas Nag, M.A., D.Litt.; *Treasurer*: K. P. Khaitan, Esq., M.A., B.L., Barrister-at-Law; *Philological and Library Secretary*: Dr Nalinaksha Dutt, M.A., Ph.D., D.Litt.; *Joint Philological Secretary*: Dr Muhammad Ishaque, M.A., B.Sc., Ph.D., *Natural History Secretaries*: *Biology*, Dr S. L. Hora, D.Sc., F.Z.S., F.R.S.E., F.N.I.; *Physical Science*, Dr K. N. Bagchi, B.Sc., M.B., F.I.C. D.T.M.; *Anthropological Secretary*, Rev.

W. C. Griffiths, M.A., B.L., B.Sc., *Historical and Archaeological Secretary*, Dr B. C. Law, M.A., B.L., Ph.D., D.Litt., F.R.A.S.B.; *Medical Secretary*, Dr Indu Bhushan Bosu, M.D.; *Other members of Council*: C. W. Gurnar, Esq., C.S.I., I.C.S., L. R. Fawcus, Esq., C.I.E., I.C.S., Percy Brown, Esq., M.B.E., A.R.C.A., F.R.A.S.B., Dr W. D. West, M.A., D.Sc., F.N.I., Maharajadhiraj Bahadur U. C. Mahtab of Burdwan, A. P. Benthal, Esq.

Dr N. R. DHAR'S ENDOWMENT TO THE UNIVERSITY OF CALCUTTA

Dr N. R. Dhar has recently made the handsome endowment of approximately one lakh of rupees to the University of Calcutta for perpetuating the memory of late Acharya Prafulla Chandra Ray and for founding a professorship in agricultural chemistry in a University College of Agriculture to be established. He has further expressed the hope of making a second endowment of another one lakh of rupees for the same purpose in the near future. In his letter to the University, Dr Dhar stated that the said professorship would be created out of the interest accruing from the securities in which the amount might be invested as soon as funds would permit. For the present, however, teaching and research posts in agricultural chemistry of such rank, status and emoluments as might be possible within the available income should be created. These posts should always be filled by Indians.

Dr Dhar was an alumni of the Calcutta University, and the gift bears testimony to his deep concern for the well-being of his *alma mater*. He thus joins the rank of Sir Tarak Nath Palit, Sir Rashbehary Ghose, Kumar Guruprasad Singh of Khaira and Sir P. C. Ray, whose princely endowments were so largely responsible for whatever progress science has made in this part of the country.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

At the Annual General Meeting of the National Institute of Sciences of India, held on January 2, 1945, at the Science College, Nagpur, the following were duly elected office-bearers and members of Council of the National Institute of Sciences of India for the year 1945: *President*: Mr D. N. Wadia; *Vice-Presidents*: Prof. S. P. Agharkar, and Sir S. S. Bhatnagar; *Treasurer*: Rai Bahadur K. N. Bagchi; *Foreign Secretary*: Prof. D. S. Kothari; *Secretaries*: Rai Bahadur S. L. Hora and Dr W. D. West; *Editor of Publications*: Prof. J. N. Mukherjee; *Members of Council*: Prof. P. R. Awati, Dr K. Bagchee, Dr S. K. Banerji, Prof. H. J. Bhabha, Khan Bahadur M. Afzal Husain, Prof. M. O. P. Iyengar, Prof. P. C. Mahalanobis, Dr K. G. Naik, Dr B. N. Prasad, Dr H. S. Pruthi, Prof. M. Qureshi, Mr B. Rama Rao, Dr L. A. Ramdas, Prof. P. Ray, Rai Bahadur J. M. Sen, Dr. A. C. Ukil, and Dr K. Venkataraman.

ANNOUNCEMENT

Sir M. Visvesvaraya, K.C.I.E., L.L.D., has been re-elected unanimously as President of the All-India Manufacturers' Organization for the year 1945.

SCIENCE IN INDUSTRY

THE MILLION VOLT X-RAY TUBE

The Machlett Laboratories, Inc., Springdale, and the General Electric Company, Schenectady, U. S. A., have recently perfected a 2,000,000 volt X-ray tube each. Prior to this development a million-volt tube developed for the testing of metal sections was known to be the most powerful X-ray tube. The 2,000,000 volt tubes have thus established a new record in the art of high-voltage tube-making.

The tube developed by the Machlett Laboratories is completely sealed off, thus obviating the necessity of maintaining high vacuum by pumping. The focussing arrangement is very fine; the electrons supplied from a greatly improved source are accelerated in several steps of 12,000 each before finally striking the anticathode with an energy of 2 million electron volt.

In the G. E. C. tube which is also vacuum sealed, the electrons from the heated filament at the top are speeded up in 24 stages until they attain the maximum energy. Tungsten backed with copper serves as the anti-cathode. The G. E. C. made use of an alloy, called fernico, between sections of glass. This alloy expands like glass and enables the metal and glass to be fused directly.

The new high-volt X-ray tubes mark a real advancement and are expected to speed up industrial operations to a remarkable extent. It is stated that the new unit requires an exposure time of only 3½ minutes in taking pictures through 8 inch steel castings, whereas the old one million volt tube takes about 4½ hours to do the same job.

ARDIL—A NEW SYNTHETIC FIBRE

THE development of a new synthetic fibre, called Ardil, by the Imperial Chemical Industries is reported in *The Chemical Age* of December 2, 1944. The new synthetic fibre resembles wool in many of its properties, such as resiliency, softness and warmth, but, unlike wool, does not shrink and is not attacked by moth. It is prepared from ground-nut protein, one ton of nuts producing about 500 lb. of Ardil fibre. The possibility of utilizing vegetable protein for the production of synthetic fibres arose out of the researches of Astbury and Chibnall. The latter's success in preparing a wool-like fibre from humpseed protein led the I. C. I. to consider the commercial utilization of this development, and ground-nut was chosen for reason of economy, and also on account of its good protein content.

Ground-nut contains 48-50 per cent arachis oil, about 28 per cent protein, 11 per cent carbohydrate, and 8 per cent salt, water, etc. The oil is first extracted from decorticated nuts by a low temperature process and may be used for human food. Protein is next extracted from the oil-free meal containing 9 per cent nitrogen, leaving a residual meal, with 2 per cent nitrogen, which may be used as a cattle-feed. The protein is then dissolved in caustic soda solution to produce the spinning solution which is extruded through spinnerets to form the filaments. The company has evolved a special method for hardening the filaments, as the traditional method with a formaldehyde bath did not prove satisfactory owing to the hydrolysis of protein. Hydrolysis was avoided by lowering the *p*H of the bath.

Ardil fibre thus obtained dyes like wool in acid dye-baths ; like wool it absorbs moisture and has a similar heat of wetting. Although fabrics may be made purely of Ardil, it is recommended that Ardil should be profitably used in mixture with wool, cotton or rayon. Yarns may be made on the worsted, woollen or cotton systems according to the type of fibre required.

The raw material for the manufacture of Ardil by the British firm will have to be supplied largely from the East, from India in particular. India ranks first in the acreage and production of ground-nuts, with China, Senegal, the U. S. A., and others following her in order of importance. India alone accounts for 34 per cent of the world production, according to an estimate covering the period 1933-37 (SCIENCE AND CULTURE, Vol. VIII, No. 2). The new process, if worked successfully on a commercial scale, is likely to lead to a great demand of Indian ground-nuts in British factories, to be processed and developed there into a far more costly fabric, for which this country will again in all probability be the principal customer. It is in this way that a supplier country of raw materials, indifferent to technological development, is deprived of wealth which could have so rightly belonged to her.

A NEW UNDERWATER CAMERA

AT a recent meeting of the Optical Society of America, (*Science*, October 27, 1944) Professor Maurice Ewing, of the Columbia University, described a new underwater camera that bids fair to be an invaluable aid to such investigations as concern the geology of the ocean's floor and the deep-sea life.

In one type, the camera is equipped with a ballast and a float. The complete unit is thrown over board, and the ballast carries it to the bottom. When it reaches the bottom, a trigger starts clock work and enables the camera to take a series of pictures at any time interval set beforehand. After the camera has been exposed for the last picture, the ballast is automatically released and the camera rises to the surface with the help of the float. In order to indicate the changes that occur in the direction of the current as the camera is active in taking pictures, it may be further provided with a compass and a drift indicator suspended in its field of view. The other camera is designed to take just one picture and is simply lowered on a wire.

The idea of obtaining photographic record of the ocean basin and of the marine life was conceived in the last century. In 1890, Boutan, a French man, first made such underwater photographs by lowering his camera into shallow water. The shutter was operated from the surface of the water by pulling on a cable attached to it. The new automatic and self-recording camera is, in fact, the latest culmination of an idea that originated fifty-four years ago.

Results of considerable geological interest have already been obtained with the new camera. A number of photographs have recently demonstrated sand ripples at 97 fathoms, proving the existence of enough current at this depth. The constancy of this movement appears from the fact that tides alter the direction of ripples.

In the study of the habits of deep-sea life, the camera has proved a valuable tool. It has made possible correct census of submarine animal population, as photographic records can include fragile and easily vulnerable fish, not possible by means of net.

MOBILE POWER PLANTS

THE war has given rise to many scientific achievements and veritable feats of engineering undreamt of even a decade ago. One such feat is the design and construction of mammoth mobile power plants for generating and supplying electricity wherever and whenever needed. The destruc-

tion of electric plants in the European, African and Asiatic theatres of war presented the problem of quickly restoring electric power for military operations as the liberation of the occupied territories proceeded on. Special trains containing full power generating equipments were designed and built for this purpose and are now serving the Allied forces with power as rapidly as they are advancing. The United States has taken the lead in developing such mammoth plants, and very recently the American Society of Mechanical Engineers, in collaboration with three of the largest engineering concerns, discussed at length the future potentialities of such equipments. As a result of these discussions, ten 5,000 kilowatt and forty-five 1,000 kilowatt mobile power plants are now being constructed by the Westinghouse Company, while the General Electric Company is constructing forty 3,000 kilowatt turbine electric power trains.

The 5,000 kilowatt train is made up of eight freight type rail road cars, each about 50 ft. in length, having double insulated walls. Of the eight cars, the first two are for the main steam generator, the third for the main turbine generator and switchboard, the fourth for air compressors and boiler feed water pump, the fifth for feed water [illegible] and the sixth and seventh for main steam generator equipment and the last for workshop and living quarters for the operating personnel. The 1000 kilowatt trains, on the other hand, have only three cars, each car being mounted on two four wheel trucks. They comprise a boiler car, a turbine generator car, a cooling tower car and a coal handling equipment. The turbine car houses the 1000 kilowatt electric generator driven by a steam turbine, a steam condenser, electrical transformer, gasoline driven generator for starting and emergency auxiliary service, and circuit breakers for main generator and feeder circuits. Both these plants are designed to obtain the maximum power output per unit of material to operate efficiently in an atmospheric temperature range from −40°F to +95°F on low grade lignite fuel with a limited quantity of water for make-up and cooling and are capable of being put into operation without power from any external source. The 3000 kilowatt electric power trains, one of which was delivered to U. S. S. R. Government last June, consist of 10 units, having locomotive boiler cars, tenders, a turbine and condenser car, a switchgear car, cooling tower cars, and a car for maintenance and operating crew.

Apart from these, smaller "Package" type floating plants of 500 watt capacity are also built by the Westinghouse. They are shipped in 24 packages made up of relatively large pre-assembled units necessary for power generation, all being mechanically and electrically interconnected. Together they comprise 8 functional units of a complete power station, each with its auxiliary equipment. They can be moved by rail, motor or water transport and assembled for power generation in 36 hours, their floor area on location being only 1870 sq. ft. The steam boiler required to produce the energy can burn coal, wood, or heat-oven green logs, fed by hand into the furnace. For handling these fuels, the plant is equipped with a tramway bucket type conveyor, a portable coal unloading conveyor, and a coal peat crusher.

The design and construction of these mobile power plants capable of readjusting the destroyed life and network of ruined cities in the shortest possible time represents an achievement of a very high order in the annals of engineering. After the needs of large cities devastated in this war have ended, these plants and probably many others that will be constructed later will have vast potentialities in general civic work, in restoring back power lost as a result of damage to the existing electric plants and machinery by fire, floods, earthquakes or explosion, while they will also find use as temporary power stations for salvage work or for hydro-electric purposes.

S. K. G.

STEEL-MIX IRON CASTINGS TO ENGINEERING SPECIFICATION

M. N. MUKERJI,

INDIAN STORES DEPARTMENT, CALCUTTA

A review of early documentary evidence shows that cast iron was also known in ancient India as "Munda". As a mater of fact, pure iron takes up carbon at about 1000°C to 1400°C and this temperature could hardly be attained in the old Indian furnaces on accoun' of their inadequate blast pressure. Some European authors, therefore, maintain that cast iron might have been produced in ancient India only by accident. A block of such iron was discovered near Rungpur, North Bengal, about fifty years ago. The chemical analysis of the sample revealed as follows:—

Iron	...	96·42%
Total Carbon	...	2·81%
Manganese	...	0·21%

On acount of its inherent low strength, brittleness and openness of grains, ordinary cast iron is still

regarded with great disfavour as a material of unreliable engineering properties, on the other hand its low cost and easy casting properties still lead the market.

The addition of steel to pig iron in a cupola would produce a stronger material so called "semi-steel" and it raises the tensile strength of cast iron. The term "semi-steel" which is sometimes used in Indian Railway Standard Drawings, Specification, technical books and journals is a vague trade name for products intermediate between steel and cast iron. Its physical properties are intermediate between cast iron and cast steel. Moreover, the term might have been originated from the fact that a certain amount of steel scrap is used in the cupola charges, say, pig iron 50%, cast iron scrap 25% and steel scrap 25%.

The essential constituents of cast iron and their physical properties are given below:

Constituent	p. wity	Tensile strength in tons per sq.in.	Elongation %	Brinell
Ferrite (Fe) ..	7·86	23	40	95
Pearlite ($Fe_{21}Fe_3C$)	7·84	53	20	197
Sorbite ($Fe_{21}Fe_3C$)	7·86	71	15	255
Cementite (Fe_3C)	7·66	2·4	None	550
Phosphide (Fe_3P)	7·32	None	Brittle	400
Graphite (C) ..	2·55	None	None	None

The introduction of steel scrap in the cupola mixture does not, as a rule, involve any reduction in the total carbon content but effects a reduction in the quantity of silicon and phosphorus in the resultant iron according to the amount of steel scrap used. The melting point of steel is about 1500°C whereas the maximum temperature of the cupola seldom exceeds 1400°C. The melting of steel in the cupola is accompanied by an absorption of carbon up to 3% up to its eutectic requirements. Indian Railway Standard Specification No. M.14-42 for iron castings has laid down 12 tons and 10 tons as minimum ultimate tensile stress for Class I and Class II respectively on 0·564 inch gauge dia. test bar. Brinell hardness number in the case of locomotive cylinder castings under Class I should be not less than 200 in accordance with B.S.S. No. 240.

We have seen sleepers on the railway track, these are either of wood or metal. The average life of an wooden sleeper is reckoned as ten years whereas the metal sleepers may last over forty years. These last named type of sleepers are manufactured either from cast iron or from pressed steel plates. I.R.S. Specification No. T. 7-36 for cast iron plates or pots for sleepers lays down that the metal used for casting the plates or pots shall be pig iron and scrap which may be either cast iron or steel. The bars for transverse strength which are called for in the Specification must be placed on knife edges 3 feet apart and these shall withstand a load of 30 cwts. applied at the centre and shall show before fracture a deflection of not less than 0·30 inch. Drop tests are conducted using a monkey weight of 420 lbs. dropping vertically on the head of the rail keyed to the plate or pot sleeper to be tested. One impact blow of the weight falling from 3 feet and three successive blows from 7 feet are specified for broad gauge sleepers. The plate or pot casting must withstand this prescribed test without showing any sign of fracture. It is customary

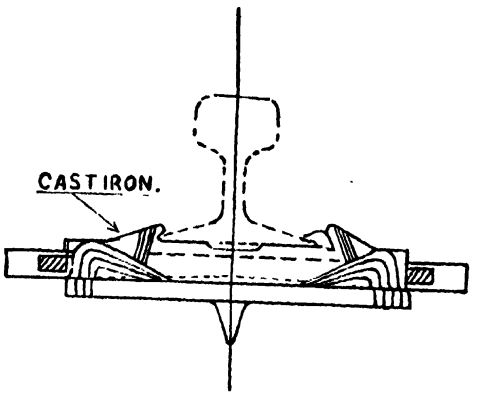


Fig. I.—Sleeper plate keyed in position for drop tests.

with the manufacturers of these sleeper plates or pots in this country to add on an average of 10% steel scrap in the cupola charges so that the resultant castings may conform to the above test requirements. The chemical composition of the sample casting as drawn approximates as follows:—

Combined Carbon	0·37%
Graphitic Carbon	2·7 %
Silicon	1·38%
Phosphorus	0·26%
Sulphur	0·08%
Manganese	0·65%

Salient features of poor strength of common cast iron as revealed by the microstructure are large graphite flakes constituting planes of weakness and hard brittle phosphide eutectic. Proper technical control of the cupola working is needed to control graphite, to reduce phosphorus and to obtain an all pearlitic structure in the final castings. The demand for improved grades of cast iron having a tensile strength greater than twelve tons per sq. in., B. S. S. No. 321 for grey iron castings was superseded by B. S. S. No. 786/38 for high duty castings which specifies 1270, 1420, 1620 and 1910 lbs. minimum breaking loads with ·11, ·12, ·13 and 0·14 inch minimum deflection on ·875 inch dia. test bar for transverse test; 16, 19, 23 and 26 tons per square inch minimum tensile strength for grades 1, 2, 3 and 4 respectively. It is imperative that the dia. of the test bar should conform to the main cross sectional thickness of the casting it represents.

In the manufacture of heavy sectioned castings where the running of the metal presents no difficulties in obtaining a perfect, clean and sound castings 30% to 40% steel scrap could be safely used. In the case of lighter sections it may be 10—15% of the charge. This charge, however, has to be melted hotter than the ordinary pig iron and cast iron scrap charges, usual coke consumption is generally higher in proportion to the amount of steel scrap used. The steel scrap should be on the top of the pig iron and cast iron charges. Volume of air is more important than pressure, say, 14 cubic feet per lb. of the charge melting. The metal may be tapped at 1400°C and cast around 1300°C. This steel-mix iron is superior to grey iron in tensile values, chemical composition, impact tests and Brinell hardness, etc. It wears better and resists shocks better than ordinary cast iron. Microstructure reveals a close grained structure consisting mainly of pearlite, some ferrite and cementite with some flakes of graphite uniformly distributed and a few patches of phosphorus eutectics.

Meehanite irons which are usually manufactured from high steel charges are now being produced by some firms in Calcutta with success. Normally we expect to get a white iron at the spout of the cupola with high steel charges but graphitization is effected by the addition of calcium silicide as an occulent.

Typical analysis of the Meehanite iron:

Total Carbon	...	2·4 —2·7%
Silicon	...	1·0 —1·5%
Phosphorus	...	0·1 —0·2%
Sulphur	...	0·05—1·0%
Manganese	...	0·65 1·0%

These special irons cost 10% to 20% more than ordinary high duty irons. Cast iron is usually made up of graphite, pearlite, ferrite and iron phosphide; malleable iron is simply made up of graphite and ferrite; meehanite consists mainly of pearlite and controlled graphite in varying forms and quantities. Meehanite castings are sometimes called "bridging the gap" between cast iron and steel. In the manufacture of meehanite, millions of tiny particles of graphite act as a nucleus in the molten metal for the formation of equiaxed crystals instead of columnar crystals which sometimes cause structural weakness. The entire process of meehanite manufacture is scientific and the resultant castings are more dependable, uniform and conform closely to Engineering Specification. They are practically displacing steel casting and forgings from the market.

A few grades of meehanite for various service requirements may be summarised as follows:—

	Typical illustrations	Tensile Min. in lbs.	Brinell Min.	Modulas of elasticity in millions per sq.in.
(1) General Engg. Castings.	Crankshafts, Hydraulic Cylinders, Tool			
GA	Shanks, Machine	50,000	223	21
GB	Tools, Units for	45,000	212	19
GC	Pumps, etc.	40,000	207	17
GD		35,000	193	15
GE		30,000	174	12
(2) Wear-resisting	Gears & Pinions (Torch hardened)			
WA	Brake Drums,	50,000	196-321	
WB	Brake Blocks,	38,000	350-550	
WBC (Chilles)	Valves, Crank, Crane Wheels, Dies, Sand Blast Nozzles, Pug Mill Knives, Pulversing Hammers.	45,000	Up to 550	
(3) Heat-resisting	Diesel Castings, Steel Guides,			
HA	Dies, Valves,	50,000	196-240	
HR	Burner Parts,	40,000	300-400	
HB	Stoker Parts,	38,000	350-500	
HE	Gas Retort Parts, Blast Furnace Parts, Fire Grate Bars & Bricks, Annealing Furnace Rails, Tempering Tanks.	30,000	170-220	
(4) Corrosion resisting Castings.	Acid Pumps, Valves, Pans, Condensers,			
CB 3	Retorts, Stills &	45,000	197	
CB	Fittings.	45,000	187	

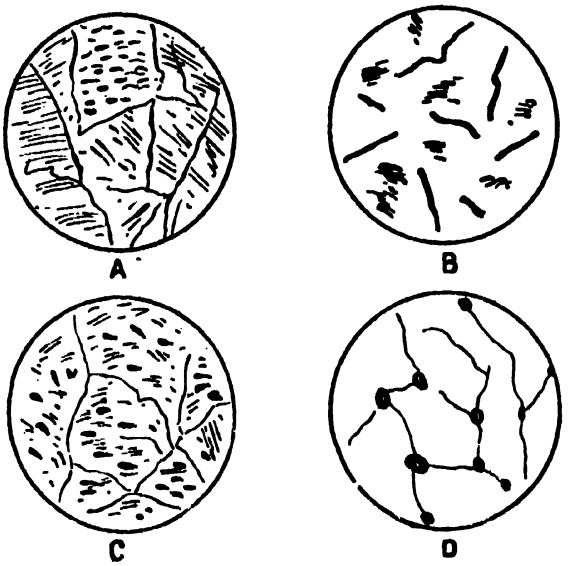


Fig. II.—(A) Carbon steel (B) Cast iron (C) Meehanite (D) Malleable iron

Present war conditions have given a great fillip to the use of steel-mix irons and it promises an ample field for the post-war development of this industry.

The writer has attempted many a time to advise small and big foundries of this country to improve on their technical control of the cupola working such as accurate regulation of quality and quantity of raw materials charged, control of chemical analysis and metallurgical structure in the final castings. In a word, the manufacturers have been impressed that they must know what they are putting in the cupola so that they may be sure what they are getting out of the cupola. On account of the proximity of coal, pig iron and sands, this part of the province is eminently suited for the foundry trade. A little technical guidance in the way of setting up a provincial "Foundry Advisory Board" in Bengal would be of immense help not only for the foundrymen but also for the advancement of foundry research in Bengal.

MEDICINE AND PUBLIC HEALTH

MENTAL DISEASES IN INDIA

MENTAL diseases in India form the subject of a useful memorandum recently prepared by Lt.-Col. M. Taylor, I.M.S., Medical Superintendent of the European Mental Hospital, Ranchi, following the request of the Medical Relief Advisory Committee under the chairmanship of Sir Joseph Bhore. The problem of mental diseases in India, about which the general public still maintain a crude and primitive attitude, has so far received far too little attention of the medical profession. A lunatic case is not regarded as a 'patient', as it should have been, but is generally treated as an alien. There is no provision for the diagnosis and treatment of early and recoverable cases, and treatment is not undertaken until the patient has fully qualified for a *bonafide* case of mental disorder, *i.e.*, has fully reached the stage of lunacy. It has now been ascertained that insanity begins before a person is insane, and if proper medical attention be taken early, the maladjustment can be cured. The accommodation in the few mental hospitals, the medical staff and other facilities are so inadequate that several voluntary boarders have to be refused admission, and the undesirable mixing of acute and recoverable cases with the chronic incurable has become inevitable.

The memorandum suggests that, as the old Indian Lunacy Act of 1912 is now out of date, better and more enlightened legal provision will have to be made. Clinics should be associated with general hospitals, whose help could be given to border line cases. Principal clinics should, however, be associated with medical schools, and provision should be made for both indoor and outdoor patients. In view of the importance attaching to the after-care of patients who have completed hospital treatment, the establishment of convalescent houses and after-care associations is recommended. Special emphasis should be laid on the much neglected teaching of psychiatry which is now looked upon by the medical profession merely as a kind of pathological curiosity. Indian colleges should also provide for better psychological training to their students inasmuch as the trained social worker has an indispensable part to play in any scheme of mental hygiene.

The memorandum has also dealt with the case of mental defectives which also present no less difficult a problem. Although wholesale sterilization is outside the scope of practical politics, it suggests that adoption of sterilization as an alternative to life-long segregation and with the consent of the defectives or their nearest relatives will be the most human course. It recommends the creation of proper institutions and utilization of hostels and colonies to house the defective population finding home environment unsuitable.

SILICO-TUBERCULOSIS

The *Medical Newsletter*, No. 41, issued by the U. S. Office of War Information, has summarized the recent work of O. Auerbach and M. G. Stemmerman on silico-tuberculosis from a paper published in the *American Review of Tuberculosis*. In order to determine whether or not pneumo-noconiosis alters or it itself altered by pulmonary tuberculosis, the authors of this study reviewed 54 cases of silico-tuberculosis and compared them with 9 cases of pneumonoconiosis without tuberculosis and 200 cases of tuberculosis without pneumonoconiosis. They found that, although silicosis and tuberculosis exist concomittantly in the same lung, each maintains its individual integrity. The tuberculosis apparently alters the silicosis not at all. The pneumonoconiosis alters the tuberculosis only in so far as the silicotic nodules prevent the full development of tuberculosis granulation tissue and, in the

walls of cavities, the pyogenic membrane. Both granulation tissue and pyogenic membrane, however, are present in those portions of the lung where the silicotic foci are small or absent. Except for this quantitative difference they found little variation in the tuberculous process, whether or not pneumonoconiosis is present. The size, situation and number of cavities are approximately the same. There is a slightly greater incidence of perforation of cavities through the interlobar fissures in the silicotics and a greater incidence of death from fatal pulmonary haemorrhage. The latter factor is due to the greater productive reaction in the silicotic lung with greater opportunity to develop an aneurysm of a branch of the pulmonary artery. They found it difficult to determine the exact time at which pulmonary tuberculosis was superimposed on pneumonoconiosis, unless the patient was under observation during the transition period, since the symptoms of the two diseases are so similar. While fever and definite evidence of cavitation on roentgenography are useful diagnostic aids, the final conclusion must be based on the demonstration of the tubercle bacillus. Collapse therapy was of little value in cases of silicotuberculosis. This is apparently due to the fact that the silicotic lung remains voluminous and shows no tendency to collapse. Most cases succumbed to progressive pulmonary insufficiency. When the tuberculous process invaded the remaining portions of resilient lung tissue sufficiently, death was inevitable.

MINIMUM REQUIREMENT OF FAT IN HUMAN NUTRITION

NIRMAL C. DUTT,

HAFFKINE INSTITUTE, BOMBAY

IT is becoming more and more evident that those nations who can provide their people with adequate diet for proper health and growth are likely to survive most in the post-war period. Today nutrition and diet are not mere matters of personal choice or individual peculiarities, but must depend on planned dietetics according to physiological needs as determined on scientific lines.

The large variety of materials which are available as human food contain substances which can be allocated to one or more certain comprehensive chemical categories or groups, the chief of which are protein, carbohydrates and fats, commonly known as "proximate" principles of food. A diet to be complete must contain all the three staminal principles, and in addition, the necessary inorganic materials in correct proportion and liberal amount of vitamins.

It is, however, to be emphasized that the quantitative aspects of dietetics are as important from the point of view of the physiology of nutrition as the quality of food. The optimum protein consumption is a matter of supreme importance, inasmuch as most of the tissue constituents are nitrogenous compounds and of necessity have their origin in food protein. An adequate diet must provide enough energy for the maintenance of body temperature and for the performance of physical work. Fats and carbohydrates are mainly concerned with the supply of energy. A marked deficiency in the ingestion of certain dietary components, such as the essential amino acids and vitamins, leads to a failure of appetite, whereas, the consumption of diet deficient in calories but adequate in other respects creates a sensation of hunger. Under the ordinary circumstances, this mechanism tends to prevent the ingestion of insufficient food fuel purpose.

In any planning of a national dietary standard, energy requirement is a matter of primary consideration. The actual amount of energy needed and, therefore, of food required, together with the proportion of the proximate principles in the diet, has been the subject of a large number of investigations. Amongst the basic researches may be mentioned those of Voit, Rubuer and Atwater, and a host of modern workers have continued similar enquiries. Our fuel requirements of the body vary considerably according to the nature of the occupation and a variety of other factors such as size, age and climate. With the present knowledge of basal metabolism and the means now available of estimating the added heat requirement for a definite amount of muscular work, including an additional allowance of energy exchange of approximately 10% due to the specific dynamic action of food, it is now possible to place such data as caloric requirement on a much more secure foundation. It has now been realized that children's needs are out of proportion to their size. The figure, 3000 calories, is now generally accepted as a sound average figure for the average man. For working class men engaged in a greater expenditure of energy calories intake of 3,000—6,000 or more per day may be necessary. Many dietaries have been proposed for the average adult man from time to time by different authorities and by scientific bodies. Some of them are shown in Table I and Table II.

The first three in table I are now chiefly of historical interest. The Food (war) Committee of the

TABLE I

STANDARD DIETARIES

	Protein	Fat	Carbohydrate	Calories
Voit (Germany) ..	118 gr.	56 gm.	500 gr.	3,065
Rubner (Germany) ..	127 ,,	52 ,,	509 ,,	3,092
Atwater (United States)	125 ,,	125 ,,	450 ,,	3,520
War Society Food (war) Committee of the Royal Society ..	100 ,,	100 ,,	500 ,,	3,390

Royal Society which met at the close of the war (1918), however, pointed out that there is a distinct relation between work and fat ration and asserted that where vigorous muscular effort has to be undertaken it is essential that the diet should contain not less than 25% of its energy in the form of fat.

Daily requirement of protein, fat and carbohydrates and total calories of an adult male, according to the report of the British Medical Association, is indicated in the Table II.

TABLE II

DIETARY STANDARD LAID DOWN BY B.M.A.
Total calories required 3,400 in food as purchases

Derived from	Quantity	Per cent of total calories	Number of calories
First class protein ..	50 gr.	6	206
Second class protein ..	50 ,,	6	206
Fat	100 ,,	27	930
Carbohydrates ..	500 ,,	61	2,050
Total	700 ,	100	3,392

Ordinarily, the protein of the diet supplies only about 300 calories per day. The protein intake need not be increased as a result of greater work, inasmuch as it is physiologically more economical to work at the expense of carbohydrates and fat. Most dietaries contain roughly four to five times as much carbohydrates as fat by weight.

Without making any alteration in the amount of protein in the diet, variation within wide limits in the relative proportion of carbohydrates and fat in isodynamic amounts are possible without injury to health. But it is not possible to replace the whole of the carbohydrates in a diet by fat or to rely upon carbohydrates to the exclusion of fat without certain disadvantage in the general metabolism of the body. Thus it is important to consider that this property of mutual replacement is not unlimited. This raises the question of the significance of fat in the diet and minimum requirement of fat in human nutrition.

DIETARY VALUE OF FAT

Fat is important as a source of energy. Its energy value is the highest of all the foodstuffs. The inclusion of fat in the diet as a concentrated source of energy makes it possible to provide sufficient calories without increasing the bulk of the food to a degree which takes the capacity of the digestive tract. Starling who served as a chairman of the Royal Society of Food (war) Committee (1918) remarked, "That the question of bulk is probably one of the most important factors in determining the need of fat. The human alimentary canal has been so developed as to cope with a diet in which 20 to 25% of the energy is presented in the form of fat. In order to get the same energy from carbohydrates the alimentary canal would have to be larger." A meal lacking in fat is deficient in staying power. People who are restricted to diets very low in fat frequently complain that they become hungry soon after meal. Premature hunger was also a universal experience during the first five months of the year 1918. Starling recites the above experiences in 1918. He has further remarked, "The ordinary individual deprived of fat diminishes his total intake of food and exists on a lower metabolic rate." There are probably some reason for this craving for fat. In the first place, when the greater part of the carbohydrate food is absorbed three hours after the food has been taken the chief absorption of fat occurs between five and six hours after a meal. On this account, individual deprived of fat get hungry sooner than when he takes fatty food. Secondly, carbohydrates are more subject to fermentative changes in the intestine than the fats. Overloading the intestine with carbohydrates leads to many individuals to abnormal production of gases and general discomfort. Although certain individual can for a time dispense with fat, yet to develop their full efficiency as a working machine, fat is an essential ingredient of the diet.

Besides their high calorific value, fats are of extreme dietary importance as a vehicle of certain fat-soluble vitamins, namely A, D and E. Animal fats are generally the potent sources of vitamins A and D. Recent studies indicate that some of the unsaturated fatty acids attain a place similar to that of the vitamins in being necessary constituents of a complete diet. Thus a deficiency disease resulting from a fat-free diet has been observed in rats (1929). The animals are said to show regularly a scaly condition of the skin, necrosis of the tail, degeneration of the kidney and in some cases, sterility. This nutritional disease is curable by the inclusion of linoleic and possibly other higher unsaturated acids or fats containing a large proportion of them. Hansen (1933), Epstein and Glick (1937) have suggested that certain eczematous conditions in humans, particularly in infants, might be related to the deficiency of essential fatty acids. It has been shown by Hansen that the blood of eczematous infants tends to have less unsaturated fatty acids than normal. Administration of

fats containing a high proportion of unsaturated fatty acids raised the degree of unsaturation of blood and in a gratifying degree alleviated the eczema. It is, however, necessary that further investigation should be continued on similar lines to clarify the relation of dietary fat to eczematous condition.

A certain amount of fat seems necessary to ensure satisfactory absorption of some nutrients of the food. F. Maignon (1934) is a strong supporter of the view that fat plays a quantitative role in nutrition affecting like vitamins, and in the utilization of food constituents. He remarks, "They have a favourable effect in the utilization of proteins for synthetic purposes and on nitrogen metabolism." There are evidences on record to show that fat helps in a better absorption of the pigment carotene, the precursor of vitamin A in the body, from the intestinal tract. Probably by far the most important effect of fat of practical nutritional significance is concerned with the absorption of calcium and phosphorus of the food. The experimental evidence for the influence of fatty acids on calcium absorption has been pointed out by a number of investigators. Holt, Courtney and Falss (1921) found that utilization of calcium by infants was augmented by fat in the diet. Some of the very recent researches indicate that fat *per se* possesses antirachitic properties. Kon and Booth (1942) seem to have definitely established this finding. Our results (to be published shortly) also lend strong support to the view that fats free of vitamin D exert a definite beneficial influence on the calcification of the bone of rats and further indicate that fat probably acts as an anti-rachitic by influencing a better absorption and retention of phosphorus from a high calcium-low phosphorus rachitogenic diet where phosphorus forms a limiting factor. Probably of relatively less practical importance is the effect of fat in delaying or averting the symptoms of vitamin B_1 deficiency, known as "the sparing action of fat on vitamin B_1."

Thus considerable experimental evidence to support the hypothesis that fat possesses some intrinsic quality of value to the organism other than supplying energy has accumulated in recent years. It has nutritional importance and physiological significance.

Fat Consumption

The actual intake of fat amongst people in various parts of the world show wide variations. In an interesting discussion of the dietary value of fat, Howe (1935) comments as follows on the consumption of fat. "In the so called standard dietaries the weight of fat consumed has varied between 50 to 100 grams per day. The average daily consumption of fats and oils purchased as such in the United States is roughly 63 grams per capita. Some dietaries in the south have shown a consumption of almost twice as much fat." The average American diet of today has been estimated to provide from 25 to 30% of its calories in the form of fat or approximately 80 to 130 grams of fat daily for the adults. In the countries of Western Europe, the feasible dietary limit has likewise been defined as approximately 80 to 125 grams per day from a varied diet of 3,000 calories. Orr (1937), by dividing the total food supply by the population, gave the average intake of fat and carbohydrates as 124 and 425 gm. respectively per "head" of population in 1934 in the United Kingdom.

Turning now to the food habits of the people of some tropical countries and in the Far East, it is found that the standard of fat intake is extremely low. Fat only accounts for 6% of the total energy value of the diet of some Japanese. Mc. Clendon (1936), while a visiting professor in Japan, writes that he "was much impressed by the low fat content of the Japanese diet and the great amount of fermentative dyspepsia among the Japanese. It seemed to me that men were incapacitated for long periods of time because of low fat content of the diet." The diet of the average rice eating population of India is also characterized by a very low intake of fat. The diet of poor rice eater who form the vast majority of the people of our country is much the same all over India. Their consumption of vegetable fat is low, that of animal fat is negligible. As to the actual intake of fat by an average Indian we have very little reliable data at hand. As reported in the *Health Bulletin* (Rice, 1940) by Dr Aykroyd, typical rice diet supplies less than 20 grams of fat daily. It is, however, correct that the influence of climate, locality, habits and work on the intake of fat is so great that it is not possible to utilize one particular standard for general application ; nevertheless, the question as to what should be the adequate intake of fat with our usual high cereal diets should receive more importance than has hithertofore been recognized.

The importance of the question of the minimum requirement of fat in human diet has now been realized, and it may be mentioned that this question was one of the subjects, which was taken up for discussion and consideration by the Technical Commission appointed by the League of Nations (1938).

Character of Fat in the Diet

In determining the minimum requirement of fat, it is, however, to be considered that the character of fat is not a matter of indifference. The choice of fat in human diet is no doubt governed by such factors as availability, local production, season of the year, personal preference and economic status. In India alone, a great variety of fats and oils are consumed in its different parts. Mustard oil is used all through-

out Assam, Bengal and Orissa, gingily and coconut oil are favoured in the south. Sweet oil is common in Bombay Presidency. In certain parts of Northern India, where milk fat is reasonably abundant and cheap, it is consumed in greater amounts more in preference to common vegetable fats and oils. As a general rule, the diet of the well-to-do class contains relatively more of butter fat. In recent years the large scale production of processed hydrogenated vegetable fats has made them available as a cheap substitute for butter. In fact, the recent increase in their consumption for cooking and other dietetic purposes may truely be called enormous. As a cheap source of energy available to the poor, the use of these products cannot be objected to, as in terms of calories, all edible fats and oils in the market are the same. However, the question arises as to whether these processed hydrogenated vegetable fats exhibit any noteworthy inequalities in respect to the coefficient of digestibility and absorbability as compared to other natural fats and oils and consequent availability for nutritive foods. It is reported by American workers from the results on human experiments that hydrogenated fats are digested with virtually the same ease and completeness as other natural fats and oils. We have found (results will be shortly published) that in regard to the relative digestion by rats of butter and hydrogenated fat, the behaviour of the two fats was practically the same but the utilization of the fatty acids of hydrogenated fat was about 3% less than butter fat. This, no doubt, can be explained as due to the large proportion of saturated fatty acids present in the hydrogenated fat. Absorption of fat depends on the length of the chain of the fatty acids and also on their unsaturation. It has been further observed that hydrogenated fat interferes with the absorption of calcium. When hydrogenated fat constitutes the sole source of fat in the diet, calcium absorption was about 14% less as compared to that obtained by feeding butter fat. The diminished absorption of calcium as effected by hydrogenated fat is caused by a greater elimination of calcium in the faeces as calcium soap. The results point to the importance in the selection of suitable dietary fat specially for the feeding of infants.

Extremely interesting results are now being reported from the studies on the comparative nutritive value of butter fat and vegetable fats. The idea which remained cogent until very recently that except for the vitamins present there is no difference in the food value of different kinds of fats is now being challenged by the gradual recognition on the possible role of certain specific essential fatty acids in the animal organism. The results of the recent researches tend to show that as the different proteins differ in their nutritive value depending on the make up and distribution of the essential amino acids in their molecular composition similarly the nutritive value of different fats and oils may be related to the presence or absence of certain specific essential fatty acids in their chemical structure. Butter fat is held superior to vegetable fat because it contains vitamin A which is lacking in the vegetable oils. Recently, however, Hart and his workers (1940, 1941) have conclusively proved that, in addition to its vitamin A content, butter fat is constitutionally superior to the vegetable oils. The superiority of butter fat is traced to a saturated acid (or acids) of high molecular weight which is not present, at least in quantity, in the vegetable oils investigated. The unsaturated portion of butter fat when reconverted into glycerides is less growth promoting than the whole. But it appears, as shown by them, that the unsaturated fraction of butter fat could be activated by hydrogenation. They further state that hydrogenation of the vegetable oils, such as corn oil, cottonseed oil, soya bean and coconut oil, did not improve their growth promoting properties. The necessity for growth and vitality of certain unsaturated acids or glycerides,, notably linoleic acid, has been recognized for some time now. The suggestion that there are certain specific higher saturated acids, peculiar to butter and not present in vegetable fats, which also exert growth promoting properties, if applied in human nutrition, will have a value of far reaching character from the practical dietetic point of view. There appears to be further room for further study of this phenomenon. This will no doubt place butter fat as an indispensible item of food in the human diet and more particularly in the diet for feeding of infants and children during the whole course of their growth period.

It may be interesting to quote the words which Leaths (1925) remarked on the role of fat in vital phenomena, "Whichever way we may turn we find that what is known of proteins points to the impossibility of accounting for the properties of the cell substances by their aid alone. Whichever way we may turn there are indications that what is known and what is possible to learn of the properties of fat must be of service. The role of fat in vital phenomena is a subject in which it may be expected that much may turn out that is of importance to the physiologists and to physicians."

Summary

It is necessary to understand that our newer knowledge of nutrition has afforded a new outlook on the question of nutritional importance of fats and fatty acids. Fats and oils are no longer to be looked upon as merely contributing in the energy they supply to the diet, but they play a role in the vital phenomena of life. Fat is essential and must be a constituent of normal human diet.

Food habits of the people of the different parts of the world show that the actual intake of fat varies from races to races. The diet of the average rice eating population of India is grossly deficient in the amount of fat. Typical rice diets supply only 20 grams of fat daily. Vegetable oils are the main source of fat in the diet of the majority of the people of India.

In the light of what is known today that, in addition to its vitamin content, butter fat is of value to the diet as supplying some essential saturated fatty acids, which may attain a place similar to that of certain vitamins, it is to be hoped that our people should be advised by the nutritional experts of our country to furnish a part of their calories requirement from animal fat such as butter. This, however, is only possible if the fat is reasonable in price.

What should be the minimum measure of fat and how much of it should be derived from butter fat and how much from vegetable sources in an ideal diet is, however, one of the many important problems, still awaiting a solution.

References

1. Aykroyd, W. R.—Indian diet and their improvement (Nutrition Abstracts and Reviews, 1941-42).
2. Anderson, W. E. and William, H. H.—"The role of fat in the diet", *Physiological Review*, *17*, 335, 1937.
3. Burr, G. O. and Burr, M. M.—*J. Biol. Chem.*, *82*, 345, 1929; *86*, 587, 1930.
4. British Medical Association Committee on Nutrition Report (1933).
5. Cameron, A. T.—"A Text-book of Biochemistry" for students of Medicine and Science, 1938.
6. Evans, H. M. and Lepkovsky, S.—"The sparing action of fat on the anti-neuratic vitamin", *J. Biol. Chem.*, *83*, 269, 1929.
7. Epstein and Glick—Archiv Dermal etc., *Syphilology*, *35*, 427, 1937.
8. Holt, Courtney and Falss—*Am. J. Dis. Child.*, *17*, 241, 1919; *19*, 97, 1929.
9. Hansen, A. E.—*Proc. Soc. Exper. Biol. & Med.*, *30*, 1198, 1932-33; *31*, 160, 1933-34.
10. Howe, P. E.—*Oil and Soap*, *12*, 4, 1935.
11. Health Bulletin No. 28, Rice 1940. Nutrition Research Laboratories, Coonoor.
12. Kon and Booth *et al.*—*J. Biochemical*, *36*, 445, 1942.
13. Leitch, I.—"The evolution of dietary standards (Nutrition Abstracts and Review), April, 1912, 509.
14. Leaths, J. B. *J. A. M. A.* "Role of fat in vital phenomena", 1925.
15. Mc. Clendon, J. F.—*J. A. M. A.*, *106*, 64, 1936.
16. Maignon, F. "The role of fat in glycogenesis and the utilization of protein" (Nutrition Abstracts and Review), 1934.
17. Orr, B. J.—"Food, Health and Income" (Macmillan), 1937.
18. Report on the physiological bases of nutrition by the Technical Commission appointed by the League of Nations (1938).
19. Royal Society Food (war) Committee (1919) Report on the food requirement of man.
20. Starling, E. H. *Brit. Med. J.*, *2*, 104, 1918.
21. Schantz, Hart *et al.*—*J. Dairy Science*, *23*, 1940; *24*, 1941.

BOOK REVIEWS

A Critical History of English Poetry.—by H. J. C. Grierson and J. C. Smith. Chatto and Windus, Pp. VIII + 527. Price 21 shillings.

Sir Herbert Grierson and Dr Smith have collaborated in writing this history of poetry to excellent purpose. That they have done it in the midst of a cataclysmal war speaks volumes for that unperturbed spirit which enabled England to weather through the darkest days ;—it would augur well for her future if her politicians could imitate the level-headed sanity of her scholars. Twenty years ago the late T. Earle Welby gave us his admirable version of the progress of English poetry. But of work such as this we cannot have too many ; for whatever one may think of England in other spheres of life, we unhesitatingly endorse M. Arnold's reminder to his countrymen that, "by nothing is England so great as by her poetry". For the mere *history* of English poetry, we believe Courthope's monumental six volumes will continue to hold the field. Neither Welby nor Profs. Grierson and Smith have attempted Courthope's admirable correlation between historical forces and literary expression. But Courthope's pages, we might say, almost reek with scholarship. It is not meant for the general reader,—the heavy atmosphere of the library is all round it. Welby wrote for the general reader ; in his work emphasis is distributed with an eye to agreeability. The present authors steer a safe middle course. Scholarship is lightened with lively enthusiasm ; appreciation is weighted with undeniable authority. Every page is alive with a freshness that challenges attention. From the opening page to the last, interest never flags, and the variety of information is not allowed to oppress. The Anglo-Saxon period is dismissed with a summary that is adequate, though space might have been found for a discussion of the influence of Christianity in modifying Nordic paganism. But we are not disposed to cavil at this since English poetry, as we know it, may be said to have been shaped by the civilizing agency of France as exerted under the Plantagenets. Welby devoted some of his most en-

tertaining pages to the influence of Provence both direct and indirect. Profs. Grierson and Smith have been more compendious, but nothing can improve their masterly resume of the evolution of romance ;—we did not know that so much completeness could be achieved within such brief compass. We might have relished a fuller treatment of *The Pearl*, specially in view of its relation to the later poetry of the Renascence and Spenser. But these are matters of individual preferences which do not affect the general excellence of treatment. A serious objection is the complete absence of all reference to the very considerable influence exerted on the literature of the romance countries, and therefore of England, by their contact with the Moors. Chivalry itself, which lies at the basis of romance, is traceable to the Saracens of Cordova, and much of the accessories of chivalry, and, we believe, almost all the oriental glow of colouring that reaches its acme in the poetry of Spenser, is directly traceable to this. Altogether satisfactory, however, is the treatment of the Italian influence generally, and that of Petrarch in particular in the fifteenth century; and the anti-Petrarchan reaction in Ben Jonson and Donne is glanced at with a happy felicity. Incidentally while the discussion of the Elizabethan sonneteers is more than sufficient, we note that the authors continue to regard Milton's use of the *enjambet* as a liberty with the Petrarchan model. We had thought that Dr Smart had conclusively shown it to be patterned on a recognised Italian model. Why Castiglione is ignored is not clear, since "The Courtrier" looms large in the poetry of Spenser, Shakespeare and other Elizabethans ; "the perfect gentleman" was much nearer to their heart than it was to the Victorians. The treatment of the Jacobeans and the Carolines is, as was to be expected, admirable, and the same might be said of the discussion of the eighteenth century poets, particularly of the satirists. That Blake should have a chapter to himself is legitimate in an age that might be said to have rediscovered him ; we would have liked to see a fuller treatment of Blake's relationship with Milton. Coming to the Romantic poets, we are unable to reconcile ourselves with the author's view of Wordsworthianism. In fact, our objection extends to almost all European critic who have undertaken this. For the Wordsworthian attitude is entirely foreign to the West ;—the proper connection between Wordsworth's predilection for silence and solitude and his communication with nature can be appreciated only through an understanding of the nature and significance of the mystic vision as immanent in a process of spiritual discipline. It is easy to expound the mysticism of Vaugham or Traherne or Blake; but to understand mystic vision that emanates from a period of probation, one must be familiar with the esoteric heritage of the Hindus. Similarly familiarity with Vaishnavite mysticism might have improved the discussion on Patmore. Indeed we have a further quarrel with the authors ;—the direct and indirect influence of Indian thoughts on latter-day English poetry is not so much as glanced at, though it is distinctly operative in much of recent poetry—including that of Hopkins, Yeats, A. E., and perhaps also of Eliot. Swinburne, in view of his influence on Kipling, Henley, and even Ezra Pound could have received more attention.

But the editor frowns and we must stop. We take leave of the book with nothing but admiration for the ease with which weighty matter is handled throughout, for the intellectual clarity displayed in ordering a many-patterned, multi-coloured tapestry. Only one suggestion we have to make. The book should include in its re-issue an account of the development of English versification—in which so much valuable work has been done in recent years. The publishers should be congratulated on the general excellence of the get-up which is pleasing to jaded eyes.

D. N. G.

Weatherwise.—By John H. Willis. George Allen and Unwin Ltd., 1944. Pp. 110, 30 plates. Price *7s. 6d.*

This book contains a record of weather at Southwell Lodge, Norwich, England, during thirty years from 1913 to 1942 by an experienced meteorological observer. It is divided into three sections. To avoid the usual method of description followed in weather reports, which may sometimes appear dull and uninteresting to ordinary readers, the author has narrated in the first section each year's weather in a flowery style. But it is doubtful whether this method of narration, which is somewhat a lengthy one, leads to a clear grasp of the main features described ; it often appears to be cumbersome.

In the second section, tables containing usual meteorological data for the thirty years are given. They give monthly and annual means and extremes of temperature and total values of rainfall and sunshine.

The most attractive feature of the book is its third section of photographs showing the effect of weather on the growth of plants and trees. These plates show the apparent condition of (*a*) the same snow-drop clump, (*b*) the same daffodil clump (*c*) the same chestnut branch and (*d*) the same branch on some fixed dates of a year, the dates being different for each of these objects. The author has not, perhaps rightly, given much space to discuss this

aspect, as further study is necessary to know the details.

Casual mention of historical events, such as Battle of Britain, has enlivened the interest of readers.

The narration gives mainly the weather of Norwich with occasional references to other parts of England; as such the sub-title of the book, "England's weather through the past thirty years" is not quite appropriate, though the chief points of interest to the public have been covered by the writer.

Inspite of restrictions due to the war, the book has been printed on paper of good quality and the reproductions of photographs are excellent.

N. K. S.

Paranormal Cognition.—By Laurence J. Bendit, M.A., M.D. (Cantab.), D.P.M., Late Assistant Physician, Tavistock Clinic, etc. Published by Faber annd Faber Ltd., London. Pp. 79. Price 5 shillings.

The book forms the text of the thesis on the basis of which the author was awarded the degree of the Doctor of Medicine by the Department of Medicine of the University of Cambridge. It is a significant sign of the times that an essay on what is popularly called 'psychism', and that too written from the standpoint of a believer, should have been considered fit for acceptance by an academic body of the standing of the Cambridge University as a doctorate thesis. The author believes, and he has cited cases of histories in support of his belief, that animals including human beings are endowed with a sixth sense, which he, following Thouless, designates as 'Psi'. The Psi functions originally guided the instinctive behaviours of animals. In human beings it works on the protopathic or subconscious level. Mediums and certain neurotics show in an eminent degree the manifestations of Psi function. The author tries to explain irrational emotional disturbances in certain patients as a Psi experience conveying the mental agitation suffered by some other person. The reviewer would like to point out that the author, like J. W. Dunne, who wrote that fascinating book 'An Experiment with Time' on an allied theme, failed to consider the possibility of paramnesia as a factor affecting the validity of the records. The recent theory of the secondary ego as developed by Bose will again do away with the necessity of any paranormal explanation for the phenomenon of experiencing other peoples' emotion in an unknown manner. Although the book may not fulfil the expectations of a rationalistic mind it will be read with great interest by all classes of readers.

S. C. M.

A Text Book of Plant Physiology (for undergraduates)—By Shri Ranjan, M.Sc. (Cantab.), Docteur ès Sciences, Professor of Botany and Dean of the Faculty of Sciences, Allahabad University. Published by Indian Press, Ltd., Allahabad, 1945. Pp. VI+228. Price Rs. 6/-.

The needs of our undergraduate (B.Sc.) students in Botany are really fulfilled by this text book and laboratory manual combined in a single volume by Shri Ranjan of Allahabad University. Since Reynolds Greens' Vegetable Physiology appeared last in 1911, no other suitable book on Plant Physiology has appeared to fulfil the requirements of our undergraduates.

The past 25 years have seen many advances made in experimental work, and in the suggestion of new theories. Prof. Ranjan has endeavoured to incorporate as much of this as seems to be sound and the material thus presented is interesting and attractive.

Each chapter has commenced with a brief historical resume of the subject and the author has even ransacked vedic literature (3000—5000 B.C.), to trace the history of the fermentation processes in plants.

The book has been kept within reasonable dimension but unfortunately certain parts *e.g.*, growth and movements have been unjustifiably compressed and some of the more important aspects of physiology of movements have not been dealt with at all. A bibliography of works referred to in the text, at the end of each chapter, would have considerably enhanced the value of the book.

The book is concluded with a chapter on the elementary principles of logarithms about which our students are often ignorant and a knowledge of which is so essential, for a correct interpretation of the physiological processes.

We have no doubt that the book will be found to be very useful to those for whom it is intended.

A. K. G.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

A NOTE ON LEAF MUTATIONS IN JUTE

In Jute the only recorded mutant, till now, was a trisome reported by Nandi[1] called V_1 hereafter. Two new mutants (V_2 and V_3) were found, early in the 1944 crop season, at Bashbari (a village near Dacca). Later in the season two plants of V_2 were located at Konda (Tipperah district), and two plants of mutant type V_1 were found, one at Narsingdi (Dacca district) and the other at Kishoreganj (Mymensingh district).

Ghose and Das Gupta[2] have dealt with the description of normal jute plants. In this note it will be shown how the mutants differ from the normal and from one another.

The V_2 mutant.—The plants are characterised by profuse branching, peculiarly cut up leaves and clusters of very small flowers. The conspicuous distinctive leaf forms, and the association of more or less complex clusters of the leaves, along with the numerous branches, gives the plant a dense bushy appearance. (Fig. 1)



Fig. 1. V_2 mutant.

The leaves differ from the normal and from those of the other mutants in not possessing a complete lamina. Segments of the leaf blade are found missing, resulting in the exposure of the midrib. The extent and the number of points at which lamina portions are wanting, varies from leaf to leaf on the same plant; in extreme cases the entire length of the midrib is exposed, except at the base where a lobe of the lamina is left. A considerable variability is present in the expression of the lamina, and a few examples of the range available are illustrated. (Fig. 2).



Fig. 2. Leaf forms of V_2 mutant.

The flowers of the mutant are tiny and much smaller than those of normal *C. capsularis*. The petals are fused with the sepals at the base up to a certain length, after which they are free and project out of the sepals forming a lip (Fig. 3).

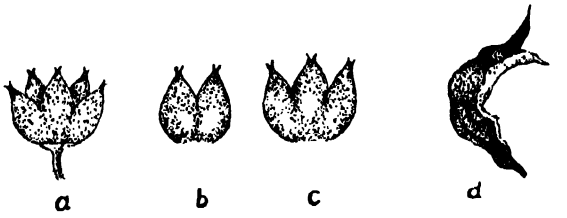


Fig. 3. *a*. apocarpous ovary, *b*. bicarpellary group, tricarpellary group, *d*. fused sepal and petal.

The stamens are greatly reduced in number, which varies from 7 to 12. All the stamens are not normally formed, one of them is petaloid, some are staminodes, yet in others the anther lobes may be partially or entirely missing exposing a barren filament without even rudiments of another at the top. In some flowers filaments of two stamens cohere. In flowers found later in the season, the staminodes are replaced by normal stamens.

The ovary is more or less apocarpous, formed of five carpels present in two groups, one of three carpels and the other of two, the margin of the

carpels are fused at the base within the groups (Fig. 3), stigma single or bifid.

No capsules are produced, but peculiar cup-shaped and discoid structures are developed towards the end of the season, as a result of the fusion of the margins of the apocarpous ovary (Fig. 4). No seeds are produced. Leaf tip smears showed that the mutant had the normal complement of chromosomes $2n=14$.

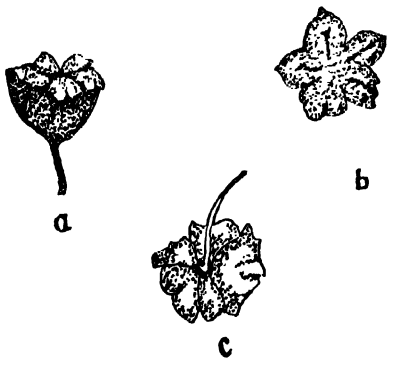


FIG. 4. *a*. cup shaped structure, *b*. discoid structure, *c*. discoid structure inverted in V_2 mutant.

The V_3 mutant. This plant proved to be a normal variant chimera, all branches, except one, had normally formed leaves. On the variant branch the leaves differed from the normal in being narrower, more deeply serrated and the lamina irregularly spread on both sides of the midrib. The leaf of V_1 differs from V_3 in being narrower, more deeply serrated and the lamina spread equally on both sides of the midvein, *i.e.*, the leaf of the mutant branch of V_3 is intermediate in breadth and serration of the lamina, between normal and V_1 leaves. Flowers small with 5-merous free sepals and petals and 10-16 stamens. Stigma trifid or fourfid.

Leaf tip smears of the V_3 mutant showed an extra chromosome in the aberrant branch giving $2n+1=15$ (Fig. 5), while rest of the branches were normal diploids with $2n=14$ chromosomes.

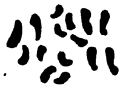


FIG. 5. $2n+1$ 15 chromosomes in V_3 mutant $\times 3200$.

Even though the V_2 mutant flowered profusely, no seeds were produced. Early in the season the flowers shed completely, but towards the end of the season, after the shedding of the sepals and petals, the peculiar cup like the discoid structures, described above, developed and were devoid of seeds.

Early in the season and again towards the middle of October pollen grain viability of the flowers were studied. From each plant a large number of flowers were examined, all the anthers (7-12) of a flower were isolated on a slide and crushed in a drop of acetocarmine and count of fertile and sterile pollen grains made.

In the early flowers the pollen grains were found to be badly formed, shrunken and completely sterile. In the later flowers, while some anthers in a flower showed a large number of sterile grains, others in the same flower showed equally large number of fertile grain, and in the rest an equal number of sterile and fertile pollen grains. The percentage of fertile pollens in anthers ranged from 18 to 96 and the mean percentage of fertile grains in flowers was 56·7.

This influence of environment on pollen fertility has been demonstrated in other crops, in *Nicotiana*, by East and Park[3] and in *Brassica Pekinensis* by Stout.[4]

In V_3 mutant some anthers have non-viable shrivelled up pollen grains. Pollen sterility count showed more than fifty per cent of non-viable grains.

R. L. M. GHOSE
J. DATTA

Jute Agricultural Research Laboratories,
Dacca, 3-12-1944.

[1] Nandi, H. K., Trisomic mutations in jute. *Nature*, *140*, 973-74, 1937.
[2] Ghose, R. L. M. and Das Gupta, B., Floral biology, anthesis and natural crossing in jute. In press.
[3] East, E. M. and Park, J. B., Studies on self sterility. The behaviour of self-sterile plant *Genetics*, *2*, 505, 1917.
[4] Stout, A. B., Cyclic manifestation of sterility in *Brassica Pekinensis* and *B. Chinensis*, *Bot. Gaz.*, *73*, 110-32, 1922

INCIDENCE OF 'BLOOD WORMS' (LARVAE OF *CHIRONOMUS* SP.) DURING AEROBIC PURIFICATION OF SEWAGE

THE larvae of *Chironomus* sp. (Chironomidae, Diptera) are commonly found in stagnant waters and occasionally in water purification systems. They may be readily recognised by their crimson colour, which has suggested the popular name of 'blood worms'. The larvae of some species of *Chironomus* are green.

The following observations mainly relate to the occurrence and development of blood worms in sewage and sewage sludges under aerobic conditions.

In the effluent channels from certain sewage farms in South India (*e.g.*, Madura), where purification is proceeding satisfactorily and the effluents are comparable to those from the activated sludge tanks,

blood worms have been found to flourish throughout the year, along with a number of ciliate protozoa (such as the species of *Epistylis, Carchesium, Zoothamnium, Vorticella,* and *Paranesium*), certain algal forms and some species of fish, all of which develop naturally and persist in all seasons of the year the different forms of life would appear to form links of the cycle of nature.

The blood worms are not normal inhabitants of activated sludge, but they occasionally make their appearance in the aeration tanks, as has been observed in most of the installations in India[1, 2], as also in a few plants at other centres[3, 4]. Fowler's observations would suggest that inadequate air-supply favours the occurrence of larvae of *Chironomous* in activated sludge and that they appear in quantity in the slowly moving sludge and completely alter its physical characteristics. Swaminathan also reported that the rapid development of *chironomous* larvae is due to defective aeration and improper circulation of sludge in the aeration tanks ; he found that the larvae lived even at very low oxygen level and collected all the sludge particles into small cylindrical masses which were buoyed up to the surface of the liquid. According to Anderson at Michigan, the production of blood worms in sewage is due primarily to stale sewage and warm temperature ; when the temperature of the sewage in the flat sewers reaches about 70°F., the treatment plant usually becomes infested with blood worms which cause a great deal of difficulty with the operation of the aeration plant ; the worms form 'cocoons of sludge', about one inch in length an one-eighth inch diameter, which adhere to the walls of the tanks and finally break loose and float on the surface of the final settling tanks, due to entrained air or the septic condition of the sludge particles. Barton at Ohio has also described the devastating effect of chironomidal infestation. At the same time, it is not clear from these accounts of the invasion of blood worms, how exactly they interfere with the process of sewage purification and how they come into the aeration tanks.

Recent researches carried out in India and in other parts of the world have revealed and established that the start as well as the efficient functioning of the activated sludge plant is essentially dependent on the development of certain special forms of protozoa, especially the members of *Epistylidae* and *Vorticellidae*[5-9]. Continued observations at Bangalore for a period of about six and a half years have conclusively shown that the efficiency of activated sludge may be referred entirely to the active presence of the special forms of protozoa, more especially the genus *Epistylis* of which some nine different species have been isolated (*Epistylis articulata, Epistylis anastatica,* etc.). Normally, the sides of the aeration tanks are densely covered with the slimy masses of *Epistylis* and activated sludge is largely made up of the protozoan colonies. These and other conditions obtaining in the activated sludge tanks are apparently favourable for the development of the blood worms, if they have a chance to come into the tanks. It has been observed that when the blood worms develop in large numbers in these tanks, they interfere with the normal development and activity of the useful protozoa. The worms attack the protozoan colonies on the sides of the tanks as also in the sludge and use them as material for making their characteristic tubes which at the same time become sources of their food supply as well. In addition to such protection and nutrition, there is adequate air supply in the aeration tanks which are therefore admirably suited for the development of the blood worms.

Observations on the incidence of *chironomus* in the aeration tanks have shown that they make their entry in two ways. If, as in the case of some installations, aeration is discontinued for some time, more especially during the nights, the adult flies come and lay their eggs directly on the supernatant liquid in the tanks, and the eggs proceed to develop into larvae. The eggs may also be taken along with the sewage and sullage into the aeration tanks, depending upon the conditions of the sewerage system.

Experiments with the blood worms in the laboratory as also those carried out on the tanks have shown that aeration is most important for their development in sewage. If the air supply is cut off, the larvae become inactive and die. They can also be killed out by using kerosine, pyrethrum powder and a few chemicals, such as copper sulphate.

Another interesting observation on the *Chironomus* larvae collected from about forty different sources (waters and sewage sludges) was that their body cavities showed the presence of certain parasitic nematodes which were identified as *Mermis* sp. Those from activated sludge were found very heavily infested, each larva showing sometimes seven or more *Mermis* at various stages of development. It may also be observed in this connection that there appears to be no record relating to the occurrence of such parasitic nematodes in the blood worms, at any rate from Indian waters and sludges.

The above observations are of very considerable scientific and practical importance introducing a new outlook in regard to the oxidation of sewage and other organic matters in nature and their re-absorption into the cycle of life.

The detailed paper will be published elsewhere.

The author's thanks are due to Prof. V. Subrahmanyan and Dr G. J. Fowler for their kind interest

in the work and various facilities placed at his disposal ; and to Mr T. V. Subramaniam, Dr B. R. Seshachar, Dr G. D. Bhalerao and Dr Baini Prasad for their kind help in identification and valuable information bearing on the subject.

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 4-12-1944. S. C. PILLAI

[1] Fowler, G. J., *Transactions of the International Conference on Sanitary Engineering, London*, p. 123, 1924.
[2] Swaminathan, N., *Journ. Ind. Inst. Sci., 12A*, 142, 1929.
[3] Anderson, R. A. *Sewage Works Journ., 15*, 928, 1943.
[4] Barton, Ben H., *Ibid., 15*, 930, 1943.
[5] Pillai, S. C., *Current Science, 10*, 84, 1941; *Ibid., 11*, 437, 1942; *Indian Medical Gazette, 77*, 118, 1942.
[6] Pillai, S. C. and Subrahmanyan, V., *Nature, 150*, 525, 1942; SCIENCE AND CULTURE, *8*, 376, 1943; *Nature, 154*, 179, 1944.
[7] Reynoldson, T. B., *Nature, 149*, 608, 1942.
[8] Edwards, Gail P., *Sewage Works Journ, 15*, 924, 1943.
[9] Larsen, C. C., *Ibid., 15*, 924, 1943.

LIFE HISTORIES OF SOME MAJOR CARPS OF BENGAL

ALTHOUGH it may sound strange to note that we are taking the major carps of Bengal as the second staple food for the time immemorial, it is certain that no complete description of their life-histories have been recorded as yet. We are running a scheme 'On the life-history, bionomics and development of the fresh water fishes of Bengal' under the Imperial Council of Agricultural Research for the last eight years and below we are giving the gist of our knowledge in this direction for the benefit of the other workers in this line. The details and discussions will be given elsewhere.

	Catla catla	*Labeo calbasu*	*Labeo gonius*	*Labeo rohita*
1. Breeding season .	June to July.	May to July.	June to July.	June to July.
2. Spawning ground	(*i*) In shallow areas forming pockets adjacent to river after a heavy shower. (*ii*) In bundhs—a special type of pond where the old water is replaced by rain water from shower or from a collection of rain water at a higher level.	Same as in *Catla catla*.	Same as in *C. catla*.	Same as in *C. catla*.
3. Structure of fertilised egg on extrusion.	Mostly spherical, light red but some are oval, 2 mm. to 2·2 mm. in diam.	Oval bluish, 1·5 in diam.	More or less spherical bluish, 1·5 mm. in diam.	Round reddish.
4. Nature of eggs ..	Demersal, non-adhesive without oil globules.	Same as in *C. catla*.	Same as in *C. catla*.	Same as in *C. catla*.
5. Size of the egg after swelling.	5·3 mm. to 6·5 mm. in diam.	3 mm. to 4 mm. in diam.	4·5 mm. in diam.	5 mm. in diam.
6. Segmentation ..	Regular; 35 min. since fertilization.	Regular; 45 min. since fertilization	Regular; 30 min. since fertilization.	Regular; 35 min. since fertilization.
(*a*) 8 celled stage	1 hr. 29 min. since fertilization.	1 hr. 30 min. since fertilization.	55 min. since fertilization.	1 hr. 10 min. since fertilization.
(*b*) 16 celled stage	1 hr. 54 min. since fertilization.	1 hr. 50 min. since fertilization.	1 hr. 25 min. after fertilization.	1 hr. 35 min. since fertilization.
(*c*) 32 celled stage	2 hrs. 19 min. since fertilization.	2 hrs. 15 min. since fertilization.	1 hr. 55 min. after fertilization.	2 hrs. 10 min. since fertilization.
(*d*) Completion of yolk invasion and formation of blastopore.	6 hrs. 30 min. since fertilization.	6 hrs. 25 min. since fertilization.	5 hrs. 25 min. since fertilization.	5 hrs. 45 min. since fertilization.
7. Appearance of embryonic rudiment.	8 hrs. 50 min. after fertilization.	8 hrs. 30 min. after fertilization.	7 hrs. 45 min. after fertilization.	8 hrs. after fertilization.
8. Appearance of optic rudiment.	11 hrs. 5 min. after fertilization.	11 hrs. after fertilization.	10 hrs. 40 min. after fertilization.	10 hrs. 35 min. after fertilization.
9. Appearance of heart rudiment.	14 hrs. 30 min. after fertilization.	14 hrs. after fertilization.	15 hrs. after fertilization.	15 hrs. 5 min. after fertilization.
10. Appearance of gill rudiment.	16 hrs. after fertilization.	14 hrs. 40 min. after fertilization.	15 hrs. 45 min. after fertilization.	15 hrs. 50 min. since fertilization.

LIFE HISTORIES OF SOME MAJOR CARPS OF BENGAL—(*Contd.*).

	Catla catla	*Labeo calbasu*	*Labeo gonius*	*Labeo rohita*
11. Appearance of pectoral fin-buds.	16 hrs. 10 min. after fertilization.	14 hrs. 40 min. after fertilization.	17 hrs. 10 min. after fertilization.	14 hrs. 30 min. since fertilization.
12. Appearance of otocyst rudiments.	14 hrs. 30 min. since fertilization.	14 hrs. after fertilization.	13 hrs. 50 min. since fertilization.	13 hrs. 20 min. after fertilization.
13. Period of incubation.	16 hrs. 40 min. since fertilization.	15 hrs. after fertilization.	16 hrs. 45 min. since fertilization.	17 hrs. 15 min. since fertilization.
14. Length of newly hatched larva.	4·2 to 4·7 mm.	4·2 mm.	3·3 mm. to 4·8 mm.	3·5 to 4·5 mm.
15. Characteristics of newly hatched larva	Eyes, otocyst, gill-slits, rudiments of pectoral fins, embryonic fin folds are present. Body laterally compressed and transparent.	Same as in *C. catla*.	Same as in *C. catla*.	Same as in *C. catla*.
16. Appearance of the median fin fold.	12 hrs. 45 min. since fertilization.	14 hrs. since fertilization.	15 hrs. 50 min. since fertilization.	14 hrs. 20 min. since fertilization.
17. Beginning of pulsation of heart.	15 hrs. since fertilization.	14 hrs. 40 min. since fertilization.	Not known.	15 hrs. 20 min. since fertilization.
18. Appearance of dorsal fin rudiment.	7th day since hatching.	8th day since hatching.	7th day since hatching.	8th day since hatching.
19. Appearance of pelvic fin rudiment.	13th day since hatching.	19th day since hatching.	198 hrs. since hatching.	18th day since hatching.
20. Appearance of anal fin rudiment.	10th day since hatching.	11th day since hatching.	162 hrs. since hatching.	12th day since hatching.
21. Appearance of scales.	31st day since hatching.	35th day since hatching.	5th week since hatching.	38th day since hatching.
22. Appearance of barbels.	No barbels.	29th day after hatching.	3rd week since hatching.	3rd week since hatching.
23. Appearance of liver	3rd day since hatching.	3rd day since hatching.	126 hrs. since hatching.	4th week since hatching.
24. Appearance of air-bladder.	2nd day since hatching.	3rd day since hatching.	24 hrs. since hatching.	2½ days since hatching.
25. Fry	Head large, transparent opercular flaps; snout long, chin compressed, no barbels, mouth anterior, toothless, body with scales.	Mouth narrow, lips fringed, snout depressed and obtuse, colour greyish, a yellowish spot at the front part of base of dorsal fin, a yellowish band at the nape, barbels black.	Head compressed, thin barbels, mouth toothless, body with scales, lip fringed, both continuous at angle of mouth no symphysical knob on lower jaw, body with longitudinal bands, fins dotted black.	Lips fringed; lower one deflected downwards and continuous, body with scales and the longitudinal bands, fins marked with vermillion red.
26. Developmental modifications of the facial structures.	*10 mm. stage.* Lower jaw bigger and upturned; gape of the mouth is 1·7 mm. eye 1 mm. nostrils not prominent.	*9 mm. stage.* Lower jaw bigger and upturned; gape of the mouth 1·6 mm. eye 0·9 mm. nostrils prominent.	*7 mm. stage.* Lower jaw bigger, narrow and upturned, no barbels, nostrils prominent, gape of the mouth 1·4 mm. eye 0·8 mm.	*10 mm. stage.* Lower jaw bigger and upturned, gape of the mouth 1·7 mm. eye 1 mm. nostrils prominent.
	14 mm. stage. Lower jaw bigger, mouth obliquely upwards, gape of the mouth 2·7 mm. eye 1·7 mm.	*12 mm. stage.* Both jaws equal, the mouth at the top of the snout, gape of the mouth 1·7 mm. each nostril divided by septum, eye 1·1 mm.	*13 mm. stage.* Upper jaw bigger, barbels developed, nostrils constricted, gape of the mouth 1·6 mm. eye 1·2 mm.	*12 mm. stage.* Jaws and mouth same as in *L. calbasu*, gape of the mouth 1·7 mm. nostrils prominent, eye 1·1 mm.
	22 mm. stage. Lower jaw much bigger, mouth upturned, gape of the mouth is 5·2 mm. lips fleshy but non-continuous, no taste buds; nostrils completely formed, eye 1·9 mm.	*12·5 mm. stage.* Upper jaw bigger, mouth on the ventral side, lips thickened and continuous, taste buds present; eye 1·1 mm., gape of the mouth 1·4 mm.	*18 mm. stage.* Upper jaw bigger, mouth ventralwards, barbels well developed, gape of mouth ·6 mm. eye 1·4 mm.	*15 mm. stage.* Both jaws are equal, mouth at the tip of the snout, lips fleshy, continuous; no taste buds; division of nostrils is complete; eye 1·3 mm., gape of the mouth 2·2 mm.

LIFE HISTORIES OF SOME MAJOR CARPS OF BENGAL.—(*Contd.*).

	Catla catla	*Labeo calbasu*	*Labeo gonius*	*Labeo rohita*
	44 mm. stage. Jaws and mouth same as in previous stage, no taste buds, gape of the mouth 8 mm. lips not continuous, eye 2·5 mm.	*16 mm. stage.* Jaws and mouth as in previous stage, gape of mouth 1·6 mm., lips fringed and contain taste-buds, eye 2 mm.	*23 mm. stage.* Upper jaw much bigger, barbels and taste buds are well developed, gape of the mouth 1·8 mm., eye 1·7 mm. Each nostril is divided by a septum.	*21 mm. stage.* Both jaws equal, mouth shifts slightly ventralwards, taste buds present, gape of the mouth 2·5 mm., eye 1·8 mm.
		23 mm. stage. Jaws and mouth as in the previous stage, taste-buds well developed, gape of the mouth 1·8 mm.	*30 mm. stage.* Mouth and lips same as in previous stage, gape of the mouth 2 mm., eye 1·9 mm.	*40 mm. stage.* Mouth ventralwards, gape of the mouth 2·6 mm., eye 2 mm.
		40 mm. stage. Aperture of the mouth narrow, gape of the mouth 2·5 mm., eye 2 mm.	*36 mm. stage.* Mouth narrow and ventral, groove behind the lower lip very prominent, lips fleshy, fringed and adapted for sucking, eye 2 mm., gape of the mouth 2·2 mm.	*47 mm. stage.* Mouth ventralwards, gape of the mouth 3·1 mm., eye 2·2 mm.
		47 mm. stage. Mouth narrow and ventral, gape of the mouth 2·9 mm., lips adapted for sucking and continuous, eye 2·2 mm.		
27. Habitat of the adult	Generally surface-feeders.	Generally bottom feeders.	Generally bottom feeders.	Generally middle-water feeders.
28. Food.				
5 mm. to 10 mm.	After yolk absorption take minute unicellular algae.	Same as in *C. catla.*	Under investigation.	Same as in *C. catla.*
1 cm. to 2 cm.	Protozoa of various nature.	Same as in *C. catla.*	Under investigation.	Same as in *C. catla.*
2 cm. to 10 cm.	Unicellular algae 10% Protozoa / Rotifer .. 6% Crustacea .. 80% Sand particles .. 1% Unidentified mass 3%	Filamentous algae 32% Unicellular algae Crustacea .. 38% Rotifer & protozoa 10% Sand particles .. 2% Unidentified mass 16% Mollusca .. 2%	Under investigation.	Unicellular algae 35 „ Protozoa / Rotifer .. 15% Crustacea .. 40 „ Sand particles .. 2 „ Unidentified mass 8 „
10 cm. to 25 cm.	Unicellular & filamentous algae 5% Rotten vegetable 10% Protozoa & Rotifer 3% Crustacea .. 65% Sand particles .. 2% Unidentified mass 15%	Unicellular & filamentous algae 12% Rotten vegetable 40% Protozoa & Rotifer 2% Crustacea .. 8% Sand particles .. 5% Unidentified mass 31% Mollusca .. 2%	Under investigation.	Unicellular & filamentous algae .. 15 „ Rotten vegetable 55% Rotifer & Protozoa 2 „ Crustacea .. 8% Sand particles .. 5% Unidentified mass 17%
More than 25 cm.	Unicellular & filamentous algae 5% Rotten vegetable 30% Protozoa & Rotifer 3% Crustacea .. 34% Sand particles .. 3% Unidentified mass 25%	Unicellular & filamentous algae 2% Rotten vegetable 50% Protozoa & Rotifer 2% Crustacea .. 3% Sand particles .. 10% Unidentified mass 29% Mollusca .. 4%	Under investigation.	Unicellular & filamentous algae .. 3% Rotten vegetable 57% Protozoa & Rotifer 2% Crustacea .. 8% Sand particles .. 5% Unidentified mass 25%

Department of Zoology,
Calcutta University,
Calcutta, 7-1-1945.

H. K. MOOKERJEE

ANOTHER SPECIES OF *PHERETIMA* FROM INDIA

THE most recent revision of Indian forms of *Pheretima*[1] recognized thirteen species, each regarded as a recent importation or immigrant. In a collection from Dehra Dun there are several specimens of a fourteenth species, *Pheretima birmanica* (Rosa, 1888). This species has been known hitherto only from a restricted area in Burma, mainly on the Shan Plateau, peripheral points of which are Toungoo Karen Hills, Kengtung, Pang Long and Mang Lung States, Bana (Yunnan), Lashio, Kutkai, and Namkham. The species gets down into the plains at Toungoo, Bhamo, Myitkyina, and has been found across the Irrawaddy only at Naba and Katha. Presence at Dehra Dun of a species which is lacking in so much of central and western Burma must be due to importation, presumably by man.

Although the species has been able to maintain itself in Dehra Dun, it does seem to be having difficulties there. Eight of the eighteen specimens had lost a posterior portion at or behind 52/53. Eight others probably had lost a posterior portion perhaps followed by some slight reorganization of the last two or three segments or by regeneration of a tail of two or three segments. The two remaining specimens appear to have tail regenerated of three and four segments only at 66/67 and 87/88.

If these interpretations are correct *P. birmanica* has a rather restricted regenerative capacity, being able to replace only two to four of the segments of lost tail portions. This is not in agreement with a rather general assumption that an anterior portion of any earthworm species can regenerate all of a lost posterior portion. Nothing, however, is certainly known of regeneration in the genus *Pheretima*.

The number of segments is 112[2]. Specimens 9 and 10 (Table 1) accordingly appear to be nearly complete. In these two worms the typhlosole ends in segments 81 and 85 which may represent about the normal termination of that structure. If so, we should expect the typhlosole to extend into the terminal segment when a posterior portion has been lost anterior to segment 80. This however is not so, the typhlosole ending 3-12 segments in front of terminal metamere in specimens 1-3. Does this indicate that loss of a posterior portion is followed by regression of the typhlosole? Some evidence for an affirmative answer may be provided by specimens 4-7 in which the tail has been lost or probably has been lost, shortly behind the region of assumed normal typhlosolar termination, for in these worms the number of post-typhlosolar segments tends to approximate the number in specimens 9-10.

TABLE 1

	Number of segments in worm	Typhlosole ends in segment	Number of post-typhlosolar segments	Posterior end
1	52	44	8	Lacking
2	65	62	3	Lacking
3	66	54	12	Regenerate of 3 segments?
4	87	63	24	Regenerate of 4 segments?
5	87	64	23	Lacking
6	90	71	19	Probably lacking
7	96	79	17	Probably lacking
8	103	76	27	Probably lacking
9	106	81	25	Probably lacking
0	109	85	24	Probably lacking

In the key of the 1937 revision, as well as in that of Bahl's memoir[3], *P. birmanica* runs down to 8b, *P. haeayana* from which it is distinguished (externally) by absence of genital markings, invaginate spermathecal and male pores.

The author's thanks are extended to Miss Marion Beebe and Miss Jane Tracy for assistance in procuring the worms.

G. E. GATES

Ewing Christian College,
Department of Biology,
Allahabad, 12-1-1945.

[1] Gates, G. E., Indian earthworms. I. The genus *Pheretima*. *Rec. Ind. Mus.*, Vol. 39, 1937.
[2] Stephenson, J., Oligochaeta, in Fauna British India, London, p. 295, 1923.
[3] Bahl, K. N., *Pheretima*, 3rd edition. *Indian Zoological Memoirs*, I. Lucknow, 1943.

Mathematics and Statistics

The Summability of A Fourier Series and its Conjugate Series

B. N. PRASAD

HISTORICALLY the summation and use of infinite series is as old as Newton and Leibnitz, or even Archimedes ; but the creation of a satisfactory *theory* is the achievement of only recent times. Although in connection with his researches on the hypergeometric series Gauss made an important and rigorous examination of infinite series and Belzano defined clearly what should constitute a convergent series this ever-growing edifice of infinite series remained without a stable foundation until it was supplied by the remarkable investigations of Cauchy and Abel. The convergence of infinite series having been disposed of, the question of *divergent* series, known as *Asymptotic series*, was taken up and developed chiefly by Poincaré and Stieltijes.

In order to utilize usefully a much wider class of divergent series other than asymptotic series, methods were devised towards the end of the last century so as to associate with them by processes closely associated with Cauchy's concept of convergence, certain values which may be called their 'sums' in a reasonable way. Such processes of the summation of series which were formerly tabooed being divergent, have recently multiplied, and the whole thing has grown into the modern rigorous theory of *summability*. Among others, mention may be made of the processes of summability commonly associated with the names of Hölder, Cesàro, Abel, Borel, Le Roy, Euler and Riesz.

The application of such processes of summation is found to be most suitable particularly in Fourier series, its conjugate series and other important allied development in Mathematical Physics. Regarding Cesàro summability of Fourier series, Fèjer obtained the fundamental result which was subsequently generalized by Lebesgue and extended further by Noaillon and W. H. Young. Recently B. N. Prasad has developed an elegant, general method by which all the previously known results and several new ones can be obtained in a simple manner.

In order to gain deeper insight and more information about the degree or mode of non-convergence or convergence of Fourier series and its conjugate series, summability of *fractional* and *negative* orders of these series has been investigated by Hardy, Littlewood, Chapman, W. H. Young, Bosanquet, B. N. Prasad and others. Recently various other types of summability like *strong* summability, *absolute summability* (A) and (C), have been applied to Fourier series and its conjugate series, and numerous results of far-reaching character have been discovered by Hardy, Littlewood, Titchmarsh, Zygmund, Plessner, B. N. Prasad, Bosanquet, Chow and a host of other workers. A comprehensive investigation of the conjugate series has been made by B. N. Prasad who has developed a powerful method which continues to remain effective even where the classical theory fails.

In spite of the tremendous amount of work done during the last hundred and fifty years in developing the theory of Fourier series the basic problem of finding a *necessary and sufficient* condition for convergence at a given point remains so far unsolved. With the processes of summability the situation, though somewhat improved, remains essentially almost the same. Nevertheless, there is hardly any important aspect of the theory of these series which have not been affected directly or indirectly by this new concept of summability.

It may be remarked that the huge amount of work that has been done in recent years in investigating the summability of a Fourier series and its conjugate series bears ample evidence to the power and potentiality of these new processes of summation. In fact, for obtaining a deeper insight into the nature of infinite series, indeed infinite integrals, the various orders in Cesàro summation may be considered to form successive steps of a long observation ladder of which the ordinary convergence is only a particular step, but if instead of taking observations while remaining fixed on this step, we do so by moving upwards and downwards on the ladder as necessity arises, we may naturally be in a better position to secure the fullest sight of our object in view. Since most of the problems in physics and allied subjects are ultimately reduced to infinite series or infinite integrals, it is not surprising that a judicious application of this new and powerful tool of a suitable type of summability process, may produce results unheard of before.

Botany

Some Aspects of Plant Anatomy in Modern Research

G. P. MAJUMDAR

PROF. MAJUMDAR divides the subject matter of his address into two parts, *viz.*, study of the cellular organization at the apices of the vegetative and flowering axes, and the importance of the study of anatomy to taxonomy. He stresses the indispensable nature of the first to the proper interpretation of the structure, development and phylogeny of plants and their functions, and tries to substantiate the contention of Prof. Bower "that it is here rather than in the mature parts that the key to causality should be sought". He then goes on to discuss the different theories propounded from time to time to interpret the cellular organization at the vegetative apex, and suggests that in the light of the present studies the Tunica-Corpus theory of the apical meristem should be revised.

With regard to the initiation of leaf primodium at the growing apex he supports from his own studies the *soubassement foliare* (foliar foundation) theory of Gregorie and Louis. He shows that at successive time intervals or plastochrones, the foliar foundation is laid at a particular sector of the growing apex on which the primordium is erected subsequently. The erection or emergence is caused by the differentiating vascular system running up from below into the foliar foundation and liberating special nutrition into the active meristem. Each foliar foundation with its vertically emergent primordium is thus really a *shoot unit*, or *phyton*, or as Schuepp, Priestley and Priestley and Scott would describe it a *growth unit*.

He then deals with the phenomena of 'Vacuolation behind the apex', and the formation of leaf gap. With regard to the formation of leaf-gap he challenges the old theory that it is caused by the basipetal influence travelling downwards from the leaf primordium, and explains that the leaf gap is caused by the basifugal impulse to more vigorous and earlier growth activity which has isolated the most vigorously growing sector of the prodesmogen cylinder in a new leaf primordium.

In describing the shoot apices of inflorescence buds he discusses the Classical theory of Floral Morphology, and also the theory that holds the carpel and stamen as reduced branch system. From his limited researches on this subject he shows that the Classical theory of Carpel Morphology cannot be supported on the grounds of developmental history. The two apices, vegetative and flowering, are fundamentally distinct and are not reducible to a common plan. In this he agrees with the late Prof. Gregorie. But pending further researches he reserves his opinion on the conclusions of Gregorie that the stamens and carpels are "microsporangiophores" and "spermatophores" respectively. Thompson, however, supported Gregorie by calling the 'embryonic or meristematic muff' at the flowering apex as the 'sporogenous meristem'. He believes that Mrs Abber is right when she says that the term homology should be dropped when comparing floral parts with foliage leaves, but keeps an open mind when Wilson regards stamens and carpels as reduced and modified branches homologuous with leaves of a similar origin.

In the second part Prof. Majumdar starts by defining anatomy and anatomical methods, and emphasizes that anatomy should be understood not in a narrow but in a comprehensive sense. This comprehensive view has given rise to the development of such studies as physiological anatomy, phylogenetic anatomy, experimental anatomy, protoplasmic anatomy, and similar other anatomical studies. He, however, confines himself to anatomy and taxonomy of flowering plants. He quotes profusely to prove the indispensable nature of anatomical evidence in establishing phylogenetic relationships in plants. In this respect invariable anatomical features are more reliable than the variable external characters. The Kew Herbarium enlists the collaboration of anatomists in determining the correct taxonomic position of plants of uncertain relationship, but he regrets to point out that the Royal Botanic Garden Herbarium at Sibpur is neglectful in this respect. He shows that allied species founded on the basis of single type specimens have been reduced on anatomical evidence in many cases to mere varieties of a single species.

But he warns against overrating of anatomical characters. He agrees with other anatomists that the endomorphic and exeomorphic characters should be employed in conjunction with each other as an auxiliary to taxonomy, as a means of confirmation of results obtained on external features.

With regard to the selection of anatomical characters only the conservative and peculiar in nature should be taken. In this connection the phyletic and biological characters should be distinguished for the phyletic is superior to biological. To obviate the difficulties of selection these characters

have been standardised. In this respect the International Association of Wood Anatomists have taken and are taking leading parts. They employ four methods for this purpose, namely, the methods of Association, Correlation, Exception and Sequences.

Prof. Majumdar concludes his address by appealing to all taxonomists of India to take anatomical features into consideration when publishing new genera and species, and to the Heads of Botany Departments at the Indian Universities to include anatomy as a major subject in the curriculum of honours and post-graduate courses.

7

Chemistry

Some Aspects of Synthetic Dyes

K. VENKATARAMAN

IT is only in recent years that the importance of the dyestuff industry to the economy of the country has been realised in India, although textiles constitute our premier industry and our annual import of dyes has been of the value of about four crores of rupees. This figure may be doubled if we provide for a rise in the standard of living and an increase in the per capita consumption of textiles to double the present figure. The history of the dyestuff industry in other parts of the world, particularly in Great Britain, its intimate relation to other chemical industries, and the experience of the two great wars are a clear demonstration of the need for organising the indigenous production of coal tar intermediates, dyes and synthetic organic chemicals.

A survey of the necessary raw materials for dye manufacture has shown that the position is on the whole favourable, and provided certain conditions are fulfilled, it is practicable to manufacture all the dyes in substantial demand in the country in 15—20 years. There are, however, many problems to be faced and solved. While the coal tar raw materials are available, or can be readily produced, our limited coal resources must be carefully conserved and utilised in a rational manner.

The inorganic heavy chemicals, consisting mainly of sulphuric, hydrochloric and nitric acids, caustic soda and soda ash, are over 90 per cent of the total raw material requirements. Although they are already being produced on a considerable scale, they are more or less fully allocated to existing industries, and it is unlikely that, with the possible exception of sulphuric acid, the dye industry will be able to draw on the present production. Further, the prices are too much high, and it may be necessary for the Indian dyestuff industry to include in its own programme the manufacture of such heavy chemicals as nitric acid by ammonia oxidation and sodium nitrite as a by-product, oleum, and sodium sulphide.

The plant requirements represent a serious problem and it will be necessary to import a considerable part of the plant, after taking the fullest advantage of engineering facilities in the country. We will have to develop ultimately a full fledged chemical engineering industry capable of producing all the machinery and equipment for the chemical industries, including the special plant which can withstand the stringent conditions of corrosion, temperature and pressure involved in modern chemical processes; but the time factor is the primary consideration, and the early establishment of dye manufacture must be made possible by entering into working arrangements with foreign manufacturers of plant. In view of the difficult and complex nature of the processes of dye manufacture, co-operation with one of the large and well established dyestuff organisations in Europe or America will be desirable, so that their technical experience may be available to us. State aid would also be required in many forms and one may recall in this connection the steps taken by the British Government during the last war to safeguard the British dyestuff industry.

Research on synthetic dyes should have ample provision in the national programme of research. The leadership of Germany in the manufacture of dyes and medicinal chemicals was mainly due to her far sighted encouragement of research. Great Britain and America were not long in learning this lesson, and it has been computed that the American dye manufacturer spends over two million dollars per year on research, devoted not only to the discovery of new dyes, but also to continuous improvement in methods of production and plant design.

SCIENCE AND CULTURE

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SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—III.

AS a result of the discussions which have appeared in the two previous issues of this series of articles it was concluded that the application of scientific methods to national welfare involve the following steps:

(*a*) To ensure (*i*) that a scientific and technological bias is given in the pre-university stage of education of the school going population and (*ii*) that advanced teaching and training in methods of research in pure and applied sciences are given in universities and professional and technological institutions of university rank.

(*b*) To provide facilities to selected groups of able students to undertake advanced training in fundamental and applied researches.

(*c*) To provide suitable organization for co-ordination and direction of research, and also to provide machinery for the utilization of results of pure research.

(*d*) To ensure the application of the results obtained to practical problems of agriculture, industry and medicine by means of pilot plants in industries, field trials in agriculture, and in public health by operation in small health areas. This represents the development stage.

(*e*) To provide agencies for the broadcasting of results obtained in the development stations to the interested sections of the community.

In the present article we shall deal with certain aspects of these problems and shall in this connection consider the recommendations which have recently appeared in several reports dealing with the different aspects of the problem of reconstruction in India. These are: Post-War Educational Development in India (will be referred to as I), Abbot Report on Vocational Education in India (II), C. E. Preston's 'Education and Training of Engineering Personnel' (III), Memorandum on the Development of Agriculture and Animal Husbandry in India (IV), and A. V. Hill's 'Scientific Research in India' (V). We are still awaiting reports of the Health Survey and Development Committee and of the Industrial Research Planning Committee.

Delimitation of Authority over Education, Research, etc. between Central and Provincial Authorities

This question has been discussed in most of these reports and the underlying principle in all their recommendations appear to be (*i*) that for all purposes of planning India is to be considered as a single geographical and economic unity, (*ii*) but for convenience of administration, a large devolution of power should be entrusted to the provincial authorities, (*iii*) but where such devolution has taken place, it will be necessary for the Central Government to exercise a large degree of control, to ensure uniformity in standards of education and opportunity for technological training and research. This will be necessary in view of the fact that the different provinces are not equally well provided with economic, agricultural and industrial resources and also not equally advanced in education and technical training. Thus for all schemes of educational and other planning it will be necessary (*a*) to establish a much closer co-operation between the Central and the Provincial Governments, (*b*) to break down existing provincial barriers, and (*c*) to introduce financial arrangements weighted down in the interest of the poorer areas. Thus it is suggested in (I) that all national planning and co-ordination of effort on a national basis will involve some kind of subsidy from Central to Pro-

vincial revenues. At the same time there will be some effective liaison between these authorities in order that the former may not only advise and assist the latter, but may also ascertain that the central subsidies are being spent on approved developments.

Further the location of technological and research institutions must largely be determined by industrial and commercial considerations and not by provincial areas. It is also necessary at the same time that in a national system students, whatever their place of origin, should have access to those institutions which provide the special training. As a consequence it will be necessary to make a drastic change in the existing system of financing education, which may be given in the form of block grants for approved schemes. But whatever form it takes, unless the whole cost of education becomes a charge on Central Revenues, which is unlikely, it will be equitable to 'weight' the formula in the interest of those provinces whose revenue producing capacity is below average.

The view is also expressed in this report that while the Provinces should remain the main units for educational administration, the activities of the higher educational centres like universities and technological institutions should be co-ordinated on an All-India basis.

Similarly in all proposals made in I and IV for the planning of research and development of agriculture, while there is a large degree of devolution of authority to the provinces regarding education, research and development, the Central authorities will (at the same time) remain responsible for the co-ordination and for supplementing the activities of the provincial authorities, which will be exercised through a Federal Department of Agriculture and Animal Husbandry, with its associated Institutes for Research and Development. The starting of a large number of All-India Commodity Committees illustrates the same tendency for the integration of research and development activities of the provinces ; each Committee will have a Central Research Station linked up with a number of regional research stations. These stations will be maintained by means of cess or duty levied on the particular commodities concerned. Advanced teaching in agriculture is, however, recognized as a provincial responsibility, and no proposal has yet been made to co-ordinate agricultural education from the centre by an All-India Committee.

On the other hand medical education imparted in the provincial medical colleges are co-ordinated by the all-India Medical Council. Medical Research is undertaken in several All-India institutions which are not in any way connected with the medical colleges and are maintained partly out of grants from the Indian Research Fund Association. We are not aware how many experimental health areas, of the type maintained at Singur, Bengal, by the Red Cross, are in existence in the whole of India. Need has been felt for associating medical research more intimately with medical colleges and universities and for the establishment of a large number of field health centres.

In technology very little has been achieved in co-ordinating higher teaching in engineering and technology on an All-India basis. Attention is drawn in I to the lack of any unifying principle in the mode of control of technical education in the provinces. In most areas such education is under the control of Labour, Commerce or Industry Department. It is pointed out that in every industrial country general and technical education is administered by the same Department of the State *viz.*, that of Education. At the same time closest contact should be maintained with Industry and Commerce, and also the technical institutions must be localized as near to industrial areas as possible. The result will be that some provinces will contain many more institutions than others. For these and other reasons stated previously, it will be necessary to establish an All-India body vested with the power to initiate, co-ordinate and control the provision for technical education, *e.g.*, by means of a National Council for Technical Education. Already an Association of Principals of Technical Institutions in India has been started, whose object is the formulation of a national policy in technical education and to establish All-India standards for courses in the major branches of technical institutions. Support of industrial research by the Central Government commenced only in 1940 with the establishment of the Council of Scientific and Industrial Research. A research laboratory under a Director has been established in Delhi, and the Council also provides grant for pure and applied research undertaken in university laboratories and research institutions.

Schemes have been approved for the starting of National Research Laboratories in Physics, Chemistry, Metallurgy and Fuel Research. Proposals have also been accepted for the starting of a number of Industrial Research Associations, which are to be maintained out of funds to be provided by the industries concerned. The Industrial Research Planning Committee will, it is expected, make detailed recommendations as to how such industrial research will be undertaken.

In addition to the different Advisory Councils and Boards maintained by the Central Government for education, research and development in agriculture, industry and medicine, the latter also maintain certain scientific departments and surveys *viz.*, in Meteorology, Geology, Geodesy, Zoology and Botany.

There is very little contact between the activities of these departments with those of similar departments in the universities.

University Education

As the universities are the source of supply of trained personnel, research workers and administrators required for industry and Government scientific departments, it will be necessary to consider in some detail the past history and present position of the Indian universities.

As is well-known the first universities were started in 1857 in the three presidency towns of Bombay, Calcutta and Madras. They were then only responsible for the conduct of examinations for the benefit of a number of affiliated but largely independent colleges. As a result of the recommendations of a number of Commissions and Committees like the Hunter Commission of 1882, the Universities Commission of 1902, the Sadler Commission of 1917, and the Hartog Committee of 1927, there has been a gradual development in the character of the universities. The purely affiliating and examining universities of the old type like that in Calcutta have developed successful departments of post-graduate teaching and research. On the other hand unitary universities have been started in Dacca, Lucknow, Allahabad, etc. It is recognized under the present conditions there is place for both types of universities in India. The principal academic difference between the two types of universities appear to be that (*i*) in the unitary universities the intermediate teaching is no longer the responsibility of the universities, but is under the control of special Boards, (*ii*) the post-intermediate course of four years is split into an honours graduate course of three years and a post-graduate M.Sc. course of one year ; while in the older universities the respective under-graduate and post-graduate course extend each over two years. There has been a great deal of discussion on the respective advantages and drawbacks of the two schemes. Our personal experience of examining the work of the candidates from both types of universities, both in the graduate and post-graduate stages, leads us to the view that a two years honours graduate course plus two years M.Sc. course provide a better specialized training in science. Probably for the purpose of competitive examinations the three years course is better suited. It has to be stressed that, unlike conditions prevalent in the United Kingdom, university training in India is considered to be completed with the Master's degree.

Some of these defects and drawbacks in university education are discussed below :

(*i*) ***Inadequacy of high school education.***—The education imparted in most of the high schools provides an inadequate preparation for a university career both in content and in teaching. The high school education being a provincial responsibility varies from province to province. The conditions are specially deplorable in Bengal, where there are about 1,400 high schools almost all of which are maintained from very inadequate fee incomes. It has to be investigated whether the education imparted during the ten-years course of school education does not lead to a deterioration of both the physical and mental efficiency of the pupils. Better provision in staff and equipment as well as a radical change of the authorities controlling high school education will be necessary before any improvement in the products of school education can be expected. National efficiency depends so much on the type of basic and school education provided for the growing generation, that it is a matter of great concern that school education is becoming so much a subject for political and religious controversies.

(*ii*) *Inadequacy of funds.*—The total expenditure in 1940-41 on university education according to I amounted to Rs. 1,65,83,971, of which 47·7 per cent came from fees, 12·9 per cent from endowments and 39·4 per cent from public funds. The total number of students during the year was 1,21,481 which represents a per capita expenditure of Rs. 300/- a year ; the actual amount for different types of education vary, being highest for medical education and lowest for education in arts subject. The number of students in 1941, who graduated in the arts subject was 32,972 and in science 10,700. This outturn of graduates is to be considered as very inadequate compared to the total population of the country, but even then previous to the present war, there was a large amount of graduate unemployment. According to the estimates given in I, only 30 per cent. of the university products can be said to have obtained employment in keeping with their attainments or commensurate with the time and money spent on their education. This indicates a failure to relate the activities of the universities sufficiently closely to the requirements of the community. Co-ordinated effort will be necessary from now to increase the avenues of employment by planned expansion of industry and agriculture and also to adjust our educational efforts to the requirements of the country. Such expansion and reorientation of university education will not be possible unless there is a considerable increase in benefactions from private sources and grants from public funds of sufficient amounts required to place the universities in a position of financial stability. So long as they remain largely dependent on students' and examination fees, the universities can hardly be expected to put such restrictions on admission as to allow high standards to be maintained, and minimize risks of graduate unemployment. It has to be recognized that adequate teaching in

science is not possible in institutions (like private affiliated colleges) whose income depends on the very moderate scale of fees which the average student can afford to pay. It is also extremely undesirable that post-graduate teaching and research should depend, as in some universities, on the allocation of a portion of the fee income received by a university for conduction of examinations. Larger grants are necessary for better provision of adequate teaching in universities, especially in science subjects. When increased funds are available, it will be desirable to establish some kind of target to the number who can be admitted to university courses in arts, science, and in professional subjects and also to establish some criteria on the relevance of different courses of study to the requirements of the community.

The present war has created a large demand for persons trained in science, technology and commerce. This has resulted in a rush for admission of students to these courses of study and in a consequent drop in admission to the arts departments of the colleges—subjects in which admissions have been lowest being Sanskrit and Philosophy, both of which are of humanistic importance. Probably when the contemplated expansion in agriculture, industry and medicine takes place, the requirements of trained personnel will parallel in many respects the demands created by the war. It will require a great deal of forethought on the part of the authorities responsible for education and development to devise plans for utilizing during the period of transition the large number of trained personnel who will be thrown out of employment with the cessation of the war industries, and also to modify during this transition period the whole system of education to meet future requirements. Otherwise a great deal of unemployment and social unrest may be engendered.

Organization of higher teaching in science and training in research.—The credit for recognizing that not only conservation and diffusion scientific knowledge but also the advancement of science by research is the function of a university belongs to the Calcutta University and to the generous donors like Taraknath Palit and Rashbehary Ghose. These two donors during 1912-13 endowed a number of research professorships in Physics, Chemistry, Applied Mathematics and Botany, and a few years later further Chairs were founded in Applied Physics and Chemistry and in Agriculture. At the same time it was recognized that research scholars should be associated with the Professors both for the purpose of training in research and for the advancement of research. The emoluments of these scholars were fixed at Rs. 75/- per month and were awarded to M.Sc. graduates for periods up to a maximum of three years. Most of the scholars so trained in research had no further opportunity of utilizing their training and had to content themselves by obtaining posts as lecturers in affiliated colleges. The standard of teaching in these colleges has improved as a result, but very few of these lecturers have either the inclination or the opportunity to continue their research. Some of the more fortunate scholars have been absorbed in industry or in Government scientific services. Need was felt for creating a limited number of junior research fellowships tenable for two years to enable the more gifted of the scholars to continue their research and qualify for Doctor's degree. A small number of post-doctorial senior research fellowships like the P. C. Ray Fellowship in Chemistry and J. C. Bose Fellowship in Biophysics have been created. In addition to these some of the industrial firms are giving grants and stipends for research in earmarked subjects.

It has been felt for some time that additional junior and senior research fellowships should be created to enable a larger number of gifted research workers to continue their post doctorial training till they can be absorbed in the universities, Government scientific services and industry. At present due to the unusual demand for trained scientific workers in war services and in industry, where the emoluments are on a much higher scale than those existing in universities and research institutions, many of the research posts cannot be filled up. Similarly a large number of sanctioned posts in Government scientific services especially in medicine and agriculture are vacant for want of suitable candidates. There is a great need for strengthening the biological departments by creating additional posts and by increasing accomodation and equipments. That biological subjects have been neglected in comparison with the physico-chemical subjects is apparent from the following example. In the Calcutta University there are four endowed chairs each, in Physics and Chemistry, pure and applied, while there are one each in Botany and in Zoology ; there is also a corresponding discrepancy in the number of research scholarships awarded in these subjects. Not only should the number of posts in science subjects be increased to meet the increased demand for science teaching and research but also the emoluments attached to these posts and the value of research stipends should also be increased in order that a proportion of the ablest minds of each generation may be attracted to such careers.

We have dealt in some detail with the provision of research in the Calcutta University, as the latter has taken the lead in associating research with teaching. The provision for science teaching and research is not uniform in other universities. In several very satisfactory progress has been made in making provisions for teaching and research, in others the conditions are less satisfactory. We find for example

that emoluments for research scholarships and fellowships vary from Rs. 30/- upwards per month. Sir S. S. Bhatnagar, in his recent presidential address to the Indian Science Congress is responsible for the following statement "I have been told that in at least two universities in India, scientific research is positively discouraged and (in the name of economy) admission to research students, inspite of willingness of the professors concerned, is almost completely prohibited." There is definite need for the setting up of some minimum standard in teaching and research in scientific subjects, to which all Indian universities should be expected to confirm to.

Co-ordination of University Education.—In response to a growing need which has been felt for some time for obtaining a large degree of co-ordination in matters of administration, and for securing some uniformity of academic standards, conditions of service, remuneration etc. amongst university teachers, the Inter University Board was started in 1925, on which the universities are usually represented by their Vice-Chancellors. The function of the Board is purely advisory and it does not possess the authority which would enable it to co-ordinate university development from the national rather than the provincial point of view. The drawbacks in the functioning of this Board according to I are that it is not able to restrain unhealthy and uneconomic rivalry between the universities in regard to new development, also to prevent the creation of new universities, the need for which has not been established, or to counteract provincial outlook which puts obstacle in the way of students seeking facilities for study which are not available in their own areas. Above all it is not invested with any power of the purse.

University Grants Committees.—Suggestions have been made in I that some authority like an Indian University Grants Committee should be established by Statute, whose main function will be to exercise a general supervision over the allocation of grants to universities from public funds, with the object of ensuring that the universities are in a position to meet such demands as may be made upon them. To enable them to plan ahead, financial assistance should be in the form of block grants for definite periods of years. It is not proposed that provincial Governments should cease to make grants direct to their local universities, unless they would prefer to do so through the Grants Committee. It is however suggested that when a provincial Government desires to make a grant to a university for any substantial new development, they would prefer to do so through the Committee. All grants from the Central Government for new university development should be through this Committee. Amongst other powers to be given to the University Grant Committee, the following have been suggested: (*i*) to co-ordinate university activities with a view to avoid overlapping and to adjust as far as possible the output of the universities to the economic needs of the country, (*ii*) to prevent undesirable competition between the universities and to remove inter-provincial barriers, (*iii*) to visit universities periodically, to ascertain their needs at first hand.

At present two leading members of the British University Grants Committee are touring this country, and are explaining to the university authorities the role of their Committee in the United Kingdom. We have not been informed how this Indian Committee is proposed to be constituted; according to I it is suggested that the Committee should consist of a few eminent persons not directly connected with any Government, Central or Provincial, or with any particular university, though for obvious reasons they should have considerable experience of university administration. The relation between the proposed Grants Committee and the Inter-university Board has not been clarified. Discussing a recent proposal for the establishment of a University Advisory Council for the United Kingdom (see previous issue), the Vice-Chancellor of the London University, Dr Frank Horton has expressed the view "the University Grants Committee has recently been reconstituted and enlarged. It has always been able to command such additional expert advice as it has needed from any academic or Government source. It is in constant touch with the Committee of Vice-Chancellor and Principals (corresponding to the Indian Inter University Board), which already fulfils some of the functions set forth above (*i.e.*, of a University Advisory Council)" Dr Horton evidently is not in favour of the establishment of the proposed Council, as in his opinion the same functions can be efficiently discharged by his Committee. We hope a similar view of the function of the Inter University Board *vis a vis* the Grants Committee will not be taken by the Central Government. The Vice-Chancellors are mostly men with non-science degrees (in 1942 out of the 10 university representatives only one had a science degree), and as such are ill equipped to speak with authority on the requirements of the science departments of their respective universities. To meet our Indian conditions it will be necessary to establish some University Advisory Council, in which the science departments should find adequate representation (see p. 361 previous article).

Recently too much stress has been laid on the desirability of vesting some authority like the University Grants Committee to co-ordinate university development with a view to avoid over-lapping and to prevent undue competition between the universities. Except in the United Provinces with its five

universities, no other province in India can be said to possess its required number of universities, and these provinces can with advantage start a few more and better equipped universities. As a measure of co-ordination, the Indian universities may be divided into four regional groups ; between the universities belonging to each group, a considerable measure of co-operation and co-ordination may be encouraged especially for purpose of post-graduate teaching and research. Need has been felt for some time for the creation of such a Grant Committee for ensuring some desirable standard of teaching in science and training in research. Results of periodic inspection of existing universities instituted by the Grants Committee may be expected to focus public attention to inadequacies of teaching, of standards of examinations, and of facilities for research, from which any particular university may suffer, and this may ensure remedial measures being taken by both the Central and the Local Government in the shape of increased grant when such is indicated and by withholding of grants when considered necessary to induce the particular university to introduce necessary reforms. One of the important function of the Grants Committee will be to lay down the conditions, financial and otherwise which must be satisfied by the local authorities before permission is accorded by the Central Government for the starting of a new university. The Committee will take into consideration the financial ability of the local authorities and recommend in what proportion the local grant to the university will be supplemented by the Central Government. There will also be other sources from which funds may be expected by universities for equipment and for maintenance of research personnel *e.g.*, from the Research Grant Committee and Research Studentship Committee of the Central Organization for Scientific Research, if the suggestion of A. V. Hill materializes. Grants for applied researches may be obtained from Federal Councils for Agricultural, Industrial and Medical Research. We may expect some indications from the Industrial Research Planning Committee of the conditions under which research on behalf of industrial firms, whose results cannot be freely published, should be undertaken.

University in relation to professional and technological training.—Having considered in some detail the problem of science teaching and training in research in the universities, we shall discuss briefly the existing relation between universities and the institutions responsible for advanced teaching and research in applied subjects like medicine, technology and agriculture.

Medical Education.—It is unfortunate that the Health Survey and Development Committee presided over by Sir Joseph Bhore have not yet published their recommendations. This Committee have been asked to make a broad survey of the present position in regard to health conditions and health organizations in British India and to make recommendations for future development. Advisory Committees have been appointed to consider questions relating to public health, medical relief, medical education, industrial health and research. We understand that the procedure followed by the Committee was to draw up tentative schemes based upon their observations and then to submit them to a group of foreign experts for their criticisms and suggestions ; the final recommendations of the Committee will be based upon modifications of their tentative proposals in light of expert criticism. We should like to see similar procedure being followed when the Central Government find it desirable to import foreign experts for enquiry and recommendations. In the absence of any report from the Bhore Committee, we shall content ourselves with giving a summary of the observations and recommendations of A. V. Hill published in his recent report (V).

The standard of teaching in pre-clinical sciences, like Anatomy, Physiology (including biochemistry and biophysics), Pharmacology, normal Psychology, in medical colleges in India is according to Hill unduly low. Routine teaching is carried on to a moderate standard, limited by staff, space and equipment, and there is little significant research. Both teaching and research is very much neglected in Physiology and Anatomy, due to the habit of running these departments on the cheap, mainly with the help of busy medical practitioners who are employed on a part-time basis. No real improvement can take place until most of the members of the pre-clinical departments hold full time appointments, reasonably well paid, in which research as well as teaching are regarded as normal duty. The pre-clinical sciences are the basis of the scientific study of medicine, and if they are weak, it will inevitably follow and it followed in India that clinical research and the standard of higher medical thought and education will be in a bad way. One of the steps necessary for improvement of medical education is the improvement of salaries status and conditions of employment of the junior staff.

In Great Britain and the United States many of the most important contributions to physiology have come in from other subjects—physics, chemistry and zoology. In India little encouragement has been given to such peoples, chiefly due to lack of funds necessary to provide full time appointments for them. As a result, physiology has not developed as an independent science, but has remained purely an adjunct to medical education. Hill suggests that a necessary step in the development of scientific medicine in India will be to start one first class department of physiology, at which teachers and re-

search workers of a new standard and a new outlook will be reared and then sent out through the whole of India. The previous criticism applies equally to most other subjects like anatomy and pharmacology and there is little provision for psychology. Biochemistry is better off because it has developed a cerain independence, and has connection with nutrition, agriculture and industry. Biochemistry should be in close touch with physiology, pathology and medicine.

Clinical Sciences.—Similar criticisms have been directed to the ill-equipped understaffed departments of Pathology and Bacteriology, most of whose members are mainly employed in earning their living in other ways than by teaching and research. An estimate is given, from the Goodenough Committee's report on Medical Education in Great Britain, of the staff required for the division of Pathology in a university medical centre, to illustrate how much the medical education in this country falls below the standard considered desirable in other countries. Even if funds were available for such increase of staff, sufficient number of people of the right calibre and experience are not available here. It will be necessary (*a*) to send able post-graduate students for training abroad, and (*b*) to establish centres of higher teaching and research in clinical sciences. There are plenty of keen able young people who given the training and the opportunity, and reasonable salary and status and prospects for the future, would be glad to devote their lives for the advancement of medicine by teaching and research. There are very few full time teachers and research workers in clinical subjects and there are no full time medical, surgical or gynaecological units. It is imperative that full time clinical units should be started in Indian Medical Colleges in all these subjects, as soon as teachers and research works of a high standard are available ; and the full time professional heads of these units should control the use of these hospitals and laboratories for all purposes of education and research.

Hill suggests that a great All-India Medical Centre should be established, an Indian 'John Hopkins' staffed in all departments by the ablest people available any where, employed full time and adequately paid, with the intention of producing the future leaders of Indian medicine and public health teachers and research workers. 'In no other subject than in medicine is it so necessary that education should be given a research atmosphere. Each patient presents a problem, each diagnosis is a theory, each treatment an experiment, often an expensive and painful one ; it seems almost a crime that the results of nearly all these costly experiments go unrecorded. In the right research atmosphere this would not be so, but in an ordinary general hospital, with a large part time staff and no provision, e.g., by an almoner's department, for 'follow up', it literally is. How can medical education produce a scientific attitude of mind in such circumstances? In fact it very seldom does.'

Medical Research.—In India by a long tradition medical research has been done in the main at special institutes, of which eight have been mentioned in Hill's report, usually quite unconnected with the medical colleges and the universities. The research department of the Indian Medical Service has been mainly responsible for this work, some of which have been very distinguished particularly in tropical medicine. There is an obvious advantage in placing talented research workers in a situation when they need not be unduly burdened by teaching and routine ; conversely however there is a disadvantage in isolating medical education and the clinical work of teaching hospitals from all contact with research. Moreover it is a serious loss to many research workers to remove them from the stimulus of young enquiring mind, and from the general scientific contact of a university. The process of setting up separate institutes in India for medical research has probably gone far enough ; some advantage would now result from bringing existing research institutes wherever practicable in closer contact with medical colleges and higher medical education. In setting up new institutes for medical research in India or in promoting new scheme of research units, the advantage of associating them with appropriate medical colleges and hospitals should be kept in mind. The criticisms and suggestions contained in Hill's report on medical education and research will, we hope, receive careful attention from the Bhore Committee. Improvement in them will require not only greatly increased grants from Central and Provincial Governments, but also a change in outlook of the medical profession and of their leaders, as well as of the politicians who control policy. There has been noticeable deterioration in the standard of medical treatment available in hospitals attached to medical colleges and of others in control of the Government in this province. In addition there is considerable room for improvement in the standards of teaching in medical colleges and of research in medical research institutions. Paraphrasing a remark of A. V. Hill we may stress that the best possible staff and students available should be attached to medical colleges regardless of other conditions—financial, religious, social, provincial and so on. If any reasons are accepted for recruitment of staff and student other than ability and character, all projected improvement in medical education and research is bound to fail.

Agricultural Education and Research.—In most provinces the agricultural colleges are affiliated to

their local universities. But so far there has been no uniformity of practice as to the qualification of the candidates considered necessary for admission to these colleges, and the period of training in them. At present, for admission to the Institute of Agriculture in Dacca, a B.Sc. degree with biological subjects is considered necessary, and the course extends over two years. In the other provinces four years post-Intermediate training is the rule. In order to meet the present acute shortage of staff required for agriculture it is suggested (IV) that courses should be recast to provide intensive technical training in a much shorter period than is considered desirable during normal times. It is also suggested that in certain cases a post B.Sc. course of two years may also be instituted. The provincial organization for head quarters research and experimental stations are usually attached to the local agricultural college. It has been suggested that the universities should be encouraged and helped to establish course for agricultural training. No suggestion is forthcoming as to the types of agricultural training which will be available in the universities and in the provincial colleges ; whether they will be similar or different. It may be desirable to organize the university courses for purpose of imparting a research bias in agricultural subjects, while the colleges will train candidates for development and extension work.

There is no proposal for establishing an All-India College of Agriculture, but a great deal of attention has been directed to the provision of facilities for research and development. The Imperial Council for Research in Agriculture and Animal Husbandry with its associated Research Institutes have been established for furthering research and development.

We suggest that there should be an All-India Council for supervision of agricultural education, for ensuring uniformity in syllabuses of the provincial colleges and for periodic inspection of these colleges, to ensure that some minimum standard of staff qualification, equipment, etc., is observed. At the same time it is desirable to establish some central authority in agriculture, to ensure that the provincial agricultural departments confirm to some minimum standard of administrative efficiency. Enquiries instituted after the recent disastrous famine in Bengal have revealed how inefficient and backward in the application of science to Agronomy the existing department of agriculture is. We would like to be informed of the contents of the report and of the recommendations of Mr L. K. Elmhirst, the well-known authority on agriculture and rural reconstruction, who was brought over as a special agricultural officer in Bengal, and what portion of it the Government of Bengal are prepared to accept.

Technological education and research.—Most of the Indian universities have engineering faculties to which the local engineering college is attached ; some of the universities have in addition faculties for technology and in others there are post-graduate courses in applied sciences. It is suggested in IV that in addition to the university courses in engineering and technology, a certain number of senior Technical Institutions of the Polytechnic type, should be started. These institutions should be started and maintained by the Central Government, and administered by an Advisory National Council for Technical Education, in which both the Central and Provincial Governments and other interested bodies will be represented. Corresponding to the university degree course there will be a full time three years National Diploma course and a further two years Advanced National Diploma course corresponding to two years university post-graduate course. The broad distinction between the respective fields and functions of the university engineering college and the engineering department of the technical colleges, is according to W. E. Fisher (as quoted in IV) one of the purpose and outlook, and is irrespective of differences of status or recognition. The task of the university is to train selected men in such a way that they may subsequently adapt themselves to the needs of whatever professional posts they may secure, while the role of the technical college is to train men in direct relation to the particular place in industry which they hope to fill. In all cases the technical college should offer its students courses appropriate to their needs, the highest courses being provided under schemes of regional co-operation if necessary. Recently a Committee under the chairmanship of Mr N. R. Sarker has been appointed who will report on the constitution, training and research to be undertaken in federal polytechnical institutes.

The present system of training for Indian university degree course in engineering suffer according to Mr Preston (IV) from certain drawbacks. The Indian courses have to a large extent been modelled on the lines of those in England. Even in regard to syllabus contents they, in many cases, represent the highest common factor of the equivalent syllabuses of English universities. But whereas in England there is a reasonably close co-ordination between universities and industry, whereby industry provides a systematic but by no means perfect practical training which is complementary to the theoretical instruction at the university, the same is not the case in India.

This author has also been struck by the dearth of engineering graduates of Indian universities who have obtained degrees of higher than ordinary "bachelor" rank. Rarely does one come across an engineering graduate who has obtained an 'honours bachelor', 'master' or 'doctor's' degree in engineering from an Indian university. Surely it is to the

universities that we must look for the best of our research workers, and the 'master' and 'doctor' degree in engineering are usually conferred for work in research field. Obviously engineering faculties are not playing their proper part in engineering research, either because facilities are not provided, or graduate students do not remain to undertake research work, or both.

Research in engineering subjects except in hydraulic appears to be lacking in this country. It is expected that opportunity for research in engineering subjects will be provided in the new technical institute and in the engineering sections of the proposed National Physical Laboratory.

The following extract from Hill's report (V) on engineering research will be found interesting. 'Among scientific and technical people in the United Kingdom the opinion is widely held that Britain has lagged behind in the provision of facilities for higher education and research in technical subjects. There is no institute as yet in the United Kingdom comparable in magnitude, in the quality of equipment, and in the excellence of teaching and research work, with the M.I.T., Cambridge, U.S.A., or indeed with several similar institutions in the U.S.A....This being the view held in England, where after all the conditions are not so bad, how much more can we recognize the importance of one or two such institutes or colleges of very high standard in India? The future of Indian industrial and agricultural development must depend on the supply of first class technical brains trained in an atmosphere both of original research and of practical experience'.

Besides these technical colleges and university courses in engineering and technology, certain universities offer a two years M.Sc. course in applied sciences. Some enquiry should be instituted to find out how these M.Sc. graduates are being absorbed in industry, the particular aptitude which is developed by such training, and what modification may be desirable for improving the usefulness of these graduates to industry and to applied research.

We have in this issue given an account of the facilities available in the country, in the universities and institutions of university standing for advanced teaching and training in methods of research in pure and applied sciences. Attention has been directed to criticisms of existing defects and to suggestions which have been made of effecting improvements. No scheme for the application of science to national welfare will be successful unless consideration is given to these fundamental problems and serious efforts are made to effect necessary improvement.

CONSERVATION OF METAL RESOURCES AND THE FUTURE OF GLASS INDUSTRY WITH SPECIAL REFERENCE TO POST-WAR PLANNING IN INDIA*

ATMA RAM,

CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, DELHI

THE economic depression from which the world at large suffered after the last Great War is still fresh in our memory. To prevent its recurrence after this war all the countries are now preoccupied in planning their industrial production on strictly scientific lines. It is now recognized that unless plans for the proper development and co-ordination of the industrial output are made well in advance, the entire world will have to face the vagaries of an economic depression far greater than the previous one.

India too has not lagged behind in these activities, and both the Government and the public are seriously considering future plans for the welfare of the country in different spheres, such as agriculture, industrial development, transport, housing, public health, education etc. The comprehensive Bombay Plan which has been drawn up by a group of progressive industrialists has attracted considerable attention both in this country and outside. Planning for the welfare of the population of a vast country can be successful only if all the aspects of the plan and their mutual relationship, both material and human, are carefully examined in relation to the resources of the country. In the case of industrial planning, one

*Paper read before the Society of Glass Technology Great Britain (Overseas Section) on 2-2-45 at Calcutta.

has to consider the relationship and influence of one industry on another, and it is only when these are taken into consideration that a full plan of industrialization of the country can be evolved. The dyestuff industry may be taken as an illustration ; it is the textile industry which is most dependent on the dyestuff industry which in turn is dependent on the textile industry for its market ; its development is dependent on the coal tar, chemical engineering and heavy chemical industries. Equally important for industrial planning is the consideration of resources. In fact, *resource planning should take precedence over the former.*

Resources

Broadly speaking material resources can be divided into two groups :

(1) *Replaceable*, such as forest and agricultural products, live stock, etc., *i.e.* those which can be renewed.

(2) *Irreplaceable*, such as minerals, coal, mineral oils, etc. which are limited, exhaustible and cannot be renewed.

The problem of conservation resolves itself into a consideration of the means by which they can be protected from wasteful exploitation. It is natural that the conservation of irreplaceable resources which are so fundamental to the development of industries should have engaged the attention of almost all the industrially advanced countries. In fact, if one goes deep many of the present day rivalries can be traced to the possession of irreplaceable resources. They can be compared to a limited capital in the sense that unchecked expenditure results in its depletion. The guiding principles in the conservation of irreplaceable resources like coal, oil, minerals etc. should be *efficient production and wise spending*. There can be only two reasonable methods of conserving these resources.

(1) An efficient and sparing use of the materials so that they can last for the maximum period possible.

(2) Substitution by other materials which can be produced from easily replaceable and replenishable resources.

In most of the countries, the above two measures are now being vigorously adopted as policies of national welfare. Even a country like the U. S. A. which possesses about half the total coal resources of the world is planning for the conservation of this key material. Other countries which have limited resources of certain essential materials are pursuing the policy of conserving them by employing substitutes. In this connection, the following general discussion which took place at the Third World Power Conference,[1] Washington, is note-worthy.

"The principles of resource planning are : (1) to hold soil, water, forest and grass *at par*, and (2) economize in the use of the irreplaceable minerals by way of every possible means. Nature lays down terms; we must obey or suffer. We can come to terms with Nature in regard to the self renewing resources by using them as fast as they are replaced. In regard to non-replaceable minerals, we can come to terms only by finding new and abundant *substitutes* faster than we use up the older materials—Technology races with waste.

Modern technology has given to the civilized man the power to support a greatly increased population by drawing more rapidly upon the material resources of the earth. For a century man has expanded his activity with little thought of the outcome. We cannot expand our destruction of forests and soil, coal and petroleum without limit. Unless we mend our ways and stop living on our capital we shall merely press against the limits of subsistence. We are threatened with a crisis in which essential materials will be exhausted and the population will have to be drastically reduced by war or starvation. Nature sets the terms; we must obey or suffer."

Metallurgical Resources and Their Conservation

The metal resources come under irreplaceable assets. Events of the present war with numerous weapons of enormous destructive power have involved the use of collosal amounts of metals. A major part of the metals has already been destroyed, and the assessment of these losses may well tax many a mathematician. When the hostilities cease, every country, rich or poor with regard to these resources, will find very discouraging estimates of the residual resources. The losses of key non-ferrous metals like copper, zinc, tin, lead, etc. have been proportionately large. After the war, one may not be surprised to find some of these nearing exhaustion. These metals are required in the production of numerous alloys, like brass, gun metal, white metal, etc. employed not only for the fabrication of utility articles for domestic consumption but also in the manufacture of special steels and of machinery and agricultural implements. After the cessation of hostilities every country will have to organize her industries, and it is natural that these resources will assume still greater importance. The Atlantic Charter whose application to every country in the world is being advocated should make provision for the conservation of irreplaceable and indispensable resources. In India, the resources of non-ferrous metals are estimated to be not very large. Even if they be considerable, the ambitious industrial developments contemplated in the Bombay Plan will entail large consumption of metals in the fabrication of machinery and implements. Moreover, for power generation and transport industries, India will require a very large amount of the

[1] Report, Third World Power Conference, *9*, 383, 1936.

metals in the form of transmission wires, electrical machinery, special parts of machinery, etc. Therefore, it is necessary that in any scheme of industrial planning the question of conservation of these resources should be critically studied from all points of view.

Without curtailing the requirements of the population, effective conservation can be attained only when proper substitutes for the metals can be found, the irreplaceable resources being reserved for essential requirements. By a curious thinking a substitute has come to be regarded as something inferior to the material it replaces. It need not necessarily be so; it can be inferior, equal or superior. What are the possible alternatives to metals where the special property of the metal is not necessary? The possible substitutes that strike one's imagination and whose resources may be considered almost inexhaustible are glass, porcelain, plastics and hardened wood.

The bulk raw materials for the production of glass and porcelain are sands, sandstones, quartz, felspars, limestones, clays and soda ash. With the possible exception of soda ash, the other materials existing on the earth's crust are recognized to be inexhaustible. Soda ash, an important constituent of glass batch, is prepared from common salt which is also abundant. With regard to plastics, the raw materials employed so far are derived both from the mineral and plant products, such as from coal and coaltar industries, the petroleum refining and cracking industries, cellulose and other plant exudations and constituents. The rapid development of the plastics industry followed the discovery of synthetic resins by Backeland. Recently plant resins such as shellac and bhilawan resin, cellulose materials like bagasse, etc. are finding increasing application in the plastics industry, but the recent trends are that for some time to come, the plastics industry will utilize synthetic materials to an even greater extent. These synthetic plastics, it should be remembered, depend on irreplaceable raw materials. There is yet no plastic industry worth considering in India. The development of the synthetic plastic industry is very intimately connected with the development of coaltar, petroleum and heavy chemicals industries which have not so far been developed in this country. In view of the variety of resins obtainable from indigenous plants, there is a great scope for developing the plastics industry from plant resins. In some of the industrially advanced countries, possibility of competition between the plastics industry on the one hand and the glass and porcelain industries on the other is being seriously examined. It is probable that, whereas plastics may substitute the use of glass to some extent, they are not likely to be serious competitors to glass; in fact, they may serve as complementary materials. In view of its non-inflammability, non-corrosive character and possibly low cost of production, glass will continue to dominte the field, especially after the invention of toughened glass which has considerably reduced its fragility. In fact, glass and plastics have become so interrelated that synthetic plastics, specially those of the transparent variety, are called organic glasses and glasses are sometime referred to as inorganic plastics. It would be unwise to minimize the importance of plastics; we are living in an age of plastics. But this does not preclude consideration of the potentialities of the glass industry and the rôle it is destined to play in post-war developments.

Glass and Porcelain -Key Industries

One of the greatest events in the entire history of glass brought about by the events of the last Great War was its transformation from an article of artistic taste to that of wide and strategic use. During this period, having been the principal material for the construction of indispensable instruments of warfare, such as field binoculars, army and navy telescopes, periscopes, range finders etc., glass assumed the importance of a strategic material. The Great War made clear the importance of the glass industry to the well-being of a nation, and in the post Great War period, the industry witnessed unparalled developments in the U. S. A. and the U. K. Few materials have found such an extensive use, and even a bare description of its uses will cover many papers.

To the scientist, whether a botanist, a geologist, a physicist, a chemist, a pathologist, an engineer, or a surgeon, glass is indispensable for the supply of a wide range of instruments and apparatus. Without glass modern science which has contributed so much to human welfare and has placed enormous resources at man's disposal, would have made little progress, for indeed glass is one of the triumvirate- the other two being steel and rubber-- largely responsible for the progress of science and technology. There is hardly any instrument which does not require glass in some form or the other. It may be stated without any fear of contradiction that there is hardly any other single substance which has contributed so much to man's knowledge of the universe. It has extended human vision from the macroscopic to the microscopic. But for glass which has provided the wonderful instrument microscope, many of the present day sciences and industries would have made little progress.

Fragility of Glass Partially Overcome

In the almost unlimited field of its utility four characteristic properties of glass have come into play optical characteristics, resistance to action of corro-

sive materials, non-combustibility and insulating properties. It is unaffected by food materials and this had led to its wide use in the household. Its extreme fragility had, however, stood in the way of its more extensive use. The recent invention of toughened glass, a material possessing high tensile strength* (still not approaching the metals), has changed the position and has extended its field of utility. Glass now bids fair to be a useful adjunct of metals in providing a really tough substitute in every field where the use of metal was necessitated not because of any specific property of the metal but because of its toughness and rigidity. In fact, this invention ranks as one of the most remarkable inventions in the history of glass technology and has led to its use in hitherto unconceived fields. Thus, it has been successfully employed in fabricating articles of furniture, high-duty machinery, *e.g.*, centrifugal pumps, flange pipes, valves, etc. In the U. S. A. all glass chemical plants and glass-lined plants have been installed for processes involving the use of corrosive materials. While the events of the last Great War demonstrated the value of glass as a material of strategic importance, the present war has established its utility as an important substitute of metals for a variety of articles. After the declaration of hostilities, there was a great drive in the U. S. A. to conserve the essential war metals. Glass came to the rescue in several ways. For instance, for articles used for domestic purposes such as dinnerware, packing containers etc. and although toughened glass articles may not have reached a state of perfection to match with the strength of metal articles, they have become sufficiently strong to withstand rough use. The Army on the field where these articles are put to rough use has found in it a material of great promise. The Quarter Master General, U. S. A. Army, has found toughened glass dinnerware very serviceable under field conditions and a substantial amount of metals required for these articles has been saved.

Some Post-War Trends

In view of the several advantages which glass possesses over metals, such as immunity to attack by foodstuffs, cleanliness, transparency and attractive appearance, glass will be preferred to metal for domestic requirements, such as cooking utensils, dinnerware, containers etc. After the war, food preservation industries which will be called upon to bear the brunt of feeding a large population are expected to undergo a wide expansion, and glass containers being now comparatively less fragile will find a large demand, incidentally helping the conservation of metals.

Another important field in which the use of glass has been surprisingly successful is in making guages for the use of factory inspectors. This is, in fact, an unpredicted development. They were being made from tough tool steel. The substitution became possible by the organized efforts of the Ordnance Department of the U. S. Army. The glass guages are considered by the Ordnance Officers equal to, if not better than, the steel guages. The following remarks of Col. H. B. Hambleton, Chief, Guage Division, Chief of Ordnance, U. S. A. are of interest.[2]

"While still more or less in the experimental stage, six months use at the Frankford Arsenal and elsewhere has proved glass guages to be the equal of, if not superior to, steel guages. In fact, so efficient are glass guages that they are fully expected to become a permanent fixture in the industrial world after the war.

"First, glass guages, with their fragility characteristics, would seem to be an anomaly which dissolves when one reviews some of the characteristics inherent in glass".

In post-war developments, in view of the rapidly depleted coal and oil resources, the world will have to look more and more to electric power. In fact, even during the war, there is already a movement to prepared harness hydro-electric resources. If the transmission of electricity at high voltage and over thousands of miles has been possible through efficient metallic conductors, the part played by the insulators in this transmission and supply is no less fundamental. Insulators are mostly made from glass, porcelain and plastics. Due to their excellent heat resisting and heat shock absorbing qualities, glass and porcelain will dominate the field, and between these two glass has many unique advantages. With the expansion in the generation, long-range transmission and use of electricity, glass which has already established its supremacy will be called upon to play a very important rôle not only as insulator for transmission but as complement parts of many electrical instruments and appliances. Moreover, the recent invention of fibre glass which is an insulatant *par excellence* for electric wires and for making insulation tape has further added to its field of utility. The enormous demand for glass articles needed in connection with the future development of electrical power in India, as envisaged in the Bombay Plan, may be easily visualized.

With the increasing emphasis on better housing and sanitary conditions, the demand for glass and porcelain articles which have proved to be of immense value in town planning, is likely to be increased several-fold. The expected expansion in the chemical, pharmaceutical, fermentation and other industries is likely to create a very large demand for glasslined vessels and an almost unlimited range of containers from the smallest phial and ampoule to the largest carboy. It may be emphasized here that glass, as a

* Imagine a sheet of glass 24″ × 6″ × ¼″, supported at its two ends, supporting the weight of Bessie, the famous (weighing 400 lbs.) American actress without breaking.

[2] Glass Industry, *24*, 69, 1943.

transparent and comparatively inactive material to chemicals and food stuffs, will always be preferred to metal containers if it can withstand rough handling. Toughened glass has at least shown the way. The invention of foam glass with its remarkable heat insulating properties and low density has provided another field for glass in refrigeration engineering, transport, housing etc. It has a decided superiority over cork in being non-combustible and more durable.

The recent discovery of plastics supported glass as a very tough material suitable for use in making aeroplane parts, and its likelihood to be of great utility for making high-duty articles has yet provided another field of application.

From the foregoing account three conclusions can easily be drawn :

(1) That in view of their limited character, their rapid depletion and their key position in the welfare of the nation, there is a strong case for the conservation of metal resources for more urgent needs.

(2) That without curtailing the requirements of the people, glass is one of the potential materials which can be of immense assistance in achieving this conservation by way of providing an excellent substitute whose resources are regarded as inexhaustible.

(3) That as a result of great technological advancement during the post-war period and its utility during the present emergency, glass in view of its fundamental properties has established itself as a material of first rank utility covering almost an unlimited field of application and has vast potentiality in future.

This discussion on the potential applications of glass as substitute for metals in the conservation programme does not imply that the activities of the metallurgical industries are to be curtailed. Far from it in post-war development the metallurgical industries are likely to be far more occupied with urgent fields of activity. For instance, in the programme of electrification, the copper industry which provides the key materials for transmission and electrical machinery may be unable to meet the requirements of the brass manufactures supplying the domestic needs of the population ; glass and porcelain can be of immediate help. One may argue that this is an alarmist view ; in the post-war period metal articles will be freely available and that glass will loose its significance as a substitute for metals. Let it be remembered that *technology runs forward*. When once the potentiality of a thing was established, technology invariably succeeded in making it a reality. The metal resources are undergoing rapid depletion, they will have to be conserved to save us from the dangers of a ruin. Human adaptability is slow, and when even during emergency we grumble to change things we are used to for new ones, in peace time the change over will take a pretty long time.

From these considerations, the versatility of glass as a key material of wide application is easily established. If, therefore, the definition of a *key industry* be one whose products are indispensable for the welfare of the country, glass by common consent will be regarded as one. It is, therefore, gratifying to note that the authors of the Bombay Plan have included glass under the *Major Industries*.

The author has written these lines by no presumption of prophecy, but with the genuine hope that these may focus the attention of those concerned with these affairs to circumstances in which we may soon find ourselves. It is now pertinent to ask the question how far the glass industry in this country is prepared to play its important rôle in post-war developments, true to the lines from George J. Overmayer.

'And so in modesty I proclaim– I am man's invaluable and versatile servant I am Glass.'

(To be concluded)

DR N. R. DHAR AND HIS ENDOWMENT

THE princely endowment of approximately one lakh of rupees which Dr N. R. Dhar had recently made to the University of Calcutta for 'perpetuating the memory of Acharya Sir Prafulla Chandra Ray and in furtherance of establishing a University College of Agriculture' was reported in our previous issue. Dr Dhar was one of the most distinguished pupils of late Acharya P. C. Ray and has been the pioneer worker in the field of physical and agricultural chemistry and allied sciences in India. Nothing could have been more fitting than the way in, and the purpose for, which he has placed such a munificent gift at the disposal of the University. The spirit in which he has made the endowment will be fully conveyed by the text of the letter addressed to the Vice-Chancellor, which we have the privilege to publish in full as follows :

Beli Road,
Allahabad,
13-11-1944.

Dear Mr Vice-Chancellor,

I desire to offer at the disposal of the University of Calcutta approximately one lakh of rupees for perpetuating

the memory of Acharya Sir Prafulla Chandra Ray and in furtherance of establishing a University College of Agriculture. The amount may kindly be used in the following way :

1. (*a*) To invest in securities the interest of which shall be utilized in creating a Professorship in Agricultural Chemistry as soon as funds permit,
 (*b*) for the present from the interest, teaching and research posts in agricultural chemistry will be created of such rank, status and emoluments as may be possible within the available income.
2. The posts mentioned above be always filled by Indians.
3. That the appointments for the posts be made by the Senate upon the recommendation of a Board formed hereafter, and the power of removal of the members of the staff by Senate, if occasion should ever arise, be exercised only after the matter has been considered fully by the said board.
4. That both postgraduate teaching and original researches should be carried on in furtherance of agricultural knowledge.
5. The Board should consist of :
 (*a*) Vice-Chancellor of the University President, *ex-officio*,
 (*b*) Dr. Shyama Prasad Mookerjee,
 (*c*) Dr. Bidhan Chandra Roy,
 (*d*) President, Post-graduate Council of Science,
 (*e*) Khaira Professor of Agriculture,
 (*f*) Two members of the Syndicate,
 (*g*) Donor, and
 (*h*) One member nominated by him both being entitled to nominate their successors, the same power to be enjoyed by the derivative members also

I hope to make a second endowment of approximately one lakh of rupees for the same purpose at a subsequent date.

As soon as I am informed that the University is willing to accept these endowments on the terms mentioned above, I shall arrange to make the necessary payment to the University.

Yours sincerely,
N. R. DHAR

Hon'ble Mr Justice R. B. Pal, LL.D.,
Vice-Chancellor,
Calcutta University, Calcutta.

The University College of Agriculture, we fervently believe, will go a long way in providing the much needed opportunity for the development of agricultural and allied sciences which have received far too little attention in this country compared to their magnitude and possibilities. It is of significance to note that the inspiration and lead come from one who has not only substantially advanced this science by his life-long researches, but who now stands true to his science by expressing a rare willingness to bequeathe to his countrymen a large share of his life's savings so that the posterity may continue the work so well begun by him. A perusal of his eventful career as a scientific worker will alone enable our readers to appreciate his supreme urge for research and development that has found so magnificent an expression in his endowment.

Dr Nilratan Dhar was born on January 2, 1892. He had his school education at Jessore Zilla School. At Calcutta, he was educated in the Ripon and the Presidency Colleges and obtained his M.Sc. degree of the University of Calcutta on submission of a thesis in physical chemistry in 1913. He was awarded a State Scholarship which enabled him to proceed to Europe and continue his research at the Imperial College of Science and Technology, London, and at the University of Paris, Sorbonne. He received the Doctorate degree of both London (1917) and the Paris (1919) Universities.

Dr Dhar has served as University Professor of Chemistry, Allahabad University, for nearly 20 years and also as Dean of the Faculty of Science for a considerable period. Since 1928, he has been carrying on very important research work in agricultural chemistry and soil science, which form the basis of agriculture, and has published numerous papers on these subjects. His discoveries in the enrichment of



DR N. R. DHAR

soil and land reclamation have been taken up in different parts of the world and have received wide recognition, as is evident from his correspondence with eminent workers in America, England and other places. He has been invited by several universities and experiment stations in Europe and America to lecture on his researches. He is a recognized authority in colloid chemistry. His three books, (1) Chemical Action on Light, (2) New Conceptions in Biochemistry, (3) Influence of Light on Biochemical Processes, are important treatises in his subject.

In his presidential address to the United Provinces Academy of Sciences, India, on December 19, 1935, Prof. N. R. Dhar gave a general account of the work carried out by himself and his collaborators on

nitrogen transformations in soil. We publish below a short review of his address which appeared in *Nature*, April 11, 1936.

"Prof. Dhar leads the school of thought which believes that nitrification in soils and nitrogen fixation from the atmosphere are, especially in the tropics, photochemical at least as much as bacterial actions. Prof. Dhar has produced strong evidence in support of his theories, and the question appears now to have reached the stage at which the protagonists of bacterial and photochemical nitrification respectively are unwilling to admit any evidence which might shatter their beliefs.

Meanwhile, other soil workers will be wise to keep an open mind on the matter, for the philosophical implications of recognising that light plays a part in soils analogous to photo-synthesis in the vegetable kingdom are at least as important as the practical possibilities of utilizing that knowledge for the enrichment of the soil. Given sufficient facts, their practical application does not necessarily depend on their correct interpretation. The practical facts of Prof. Dhar's researches are that Indian soils are generally deficient in nitrogen, that more than half a million tons of molasses from the sugar industry are annually wasted in India, and that the application of molasses to the soil can double and may treble the soil nitrogen content, with a consequent large increase in crop yield.

Molasses contains about 70 per cent. of carbohydrates and small quantities of nitrogen, phosphorus, potash, etc., these quantities, however, being much too small to account for the observed manurial effect. According to Prof. Dhar, the energy set free in the oxidation of the sugars in molasses is utilized, either bacterially or photochemically, in promoting nitrogen fixation and nitrification. Whatever the nature of the process, Dhar has produced indisputable evidence of increases in available soil nitrogen and crop yield following the application of molasses. Under temperate conditions, the converse result would be expected, as it is well known that the addition of carbohydrate-rich material to soil tends to reduce the amount of nitrogen available to plants, the nitrogen becoming fixed as microbial protoplasm or as humus. An essential difference, however, between temperate and tropical soil requirements is that, whereas in temperate regions the limiting factor to crop growth is often the slowness, in the tropics it is the rapidity with which soil nitrogen is made available to plants, soluble nitrates being formed and leached from the soil before they can be absorbed by the crop. The general effect of molasses on the soil should be the same everywhere, but only in the tropics will its 'braking' effect on the mobilization of soil nitrogen be a positive advantage to the cultivator, and only in the tropics will its stimulation of atmospheric nitrogen fixation, whether bacterial or photochemical, be appreciable, since temperate regions lack the heat necessary for bacterial and the light for photochemical stimulation.

For these reasons, the potentialities of carbohydrate manuring of which molasses manuring is an example- have perhaps been overlooked by agriculturists. If Prof. Dhar can substantiate his claims, he may effect a revolution in agriculture in India, where the supply of the ordinary organic manures is far below the demand. Prof. Dhar suggested that a most valuable use can be made of molasses in reclaiming alkaline land. The acids produced in the decomposition of molasses neutralize the alkalis, and at the same time and contrary to experience when land is reclaimed with gypsum or sulphur, soil nitrogen is increased. A period of about four years is usually necessary to reclaim alkali land with gypsum, whereas with molasses applied at a rate of 30-40 tons per acre, good crops can be grown within six months. It is not stated whether such reclamations have been found permanent—in view of the oxidisability of the neutralising acids, this is open to doubt—but the method obviously merits further study. There are four million acres of infertile alkali land in India, and irrigation practices are increasing the area. The economic reclamation of these lands is one of the country's greatest agricultural problems, to the solution of which Prof. Dhar's work is pointing the way."

Dr Dhar has created a big school of scientific research in agricultural chemistry and allied subjects. Several of his pupils who have carried on research work in agricultural chemistry and allied subjects under Dr Dhar are holding important posts in different parts of India, *e.g.*, Dr K. C. Sen, Director, Imperial Dairy Research Institute, Bangalore, Dr N. G. Chatterji, Officer-in-Charge, Power Alcohol, U. P., Dr P. B. Ganguly, Professor of Chemistry and Principal, Science College, Patna, Dr A. C. Chatterji, Reader, Lucknow University, Dr S. Ghosh, Reader, Allahabad University, Dr V. Gore, Professor, Science College, Nagpur, Dr D. N. Chakravarti, Professor, Science College, Nagpur, Dr H. L. Dube, Lecturer, Allahabad University, Dr B. K. Mukerji, Agricultural Chemist, U. P. Government, now Deputy Director of Agriculture, U. P. Government, Dr Gopala Rao, Reader, Andhra University, Dr S. K. Mukerji, Soil Chemist, U. P. Government, Dr N. N. Pant, Professor, Meerut College, now on active service, Dr S. P. Srivastava, Agricultural Chemist, Bharwari Farm, Jhansi, Dr Sant Prasad Tandon, Lecturer, Allahabad University, Dr E. V. Seshacharyulu, Bio-Chemist, Imperial Dairy Research Institute, Bangalore.

For over 10 years Dr Dhar has been maintaining a big research laboratory known as the Indian Institute of Soil Science in Allahabad and he has been designated as Officer-in-Charge of this laboratory by the U.P. Government. In this institution very important researches on nitrogen fixation and alkali land reclamation have been carried on. The Imperial Council of Agricultural Research sanctioned Rs. 10,000/- for meeting the expenses of these researches. The U. P. Government also contributed to this institution Rs. 10,000/- for research work in agricultural chemistry. Dr Dhar has delivered lectures on soil science and visited the Agricultural Institutes in the Universities of Cambridge, London, Paris, Uppsala, Groningen (Holland) and Wageningen (Holland). He was invited by the International Fertilisers Congress to write and present a report on the fertilisation of dry soils to the Congress held in Rome in 1938. Dr Dhar was invited and attended the International Agricultural Conference in Holland in 1937. He served on the International Nobel Prize Committee in Chemistry in 1939. He was president of the Indian Chemical Society 1933-35 and the Chemical section of the Indian Science Congress in 1922. He has been serving as an examiner in agricultural chemistry in the universities of Allahabad, Agra, Lucknow and other places and served on the Soil Science Committee of the Imperial Council of Agricultural Research.

LIFE-HISTORY AND BIONOMICS OF THE CAULIFLOWER PEST, *PRODENIA LITURA*, Fb., IN BENGAL

A. C. BASU,
ADDITIONAL ENTOMOLOGICAL ASSISTANT, GOVERNMENT AGRICULTURAL LABORATORY, TEJGAON, DACCA

IN Bengal, the larva of the moth, *Prodenia litura*, Fb., (Noctuidae, Lepidoptera), is a major pest of the cauliflower. It is damaging not only to this particular crop, but also to many other economic plants and fruits in India as well as in other parts of the world. In Egypt, the larva is a great enemy to the cotton plants and is known there as the cotton-worm ; in Nyssaland, the larva injures the tobacco plants, and is popularly called the tobacco-caterpillar ; in Rhodesia it is called the tomato-caterpillar ; in Mauritius, it is known as the bean-army worm. In the Tamil areas of the Madras Presidency the larva is known as *'arakkan'*, and in Bengal where the devastation of the cauliflower by this larva is alarming to the peasantry, it is popularly described as the *'kafipoka'*, the cauliflower worm.

Since the larva causes damage to economic crops of the globe, it has been a subject of investigation by entomologist. Wilcock (1905) furnished some information on this moth, and made a list of host plants devastated by its larva. Fletcher (1914) gave some accounts on the general habits of the moth and the larva with notes on plants which might be injured by *P. litura*. Janish (1930) carried on observations on this moth under different grades of temperatures. Bishara (1934) added an elaborate account on the bionomics and prepared a list of plants, fruits and flowers injured by the larva of *P. litura*. Raichoudhury and Basu (1941) noted its pupa formation in relation to its pupating media. Basu (1943) recorded observations on the effect of the different food-stuffs on the variations of the larval growth, pupal size, period and the size of the moth of *P. litura*. In view of the importance of this pest its life history together with brief notes on the morphological peculiarities is given below.

Description of various Stages in the Life-History

The Egg (Fig. 1).—The eggs are laid in small patches. Sometimes a second and a third batch are deposited over the first patch. The egg is round, when just oviposited it is iridescent in colour. Just prior to hatching the egg assumes a black tint. The larva emerges on cutting a hole in the chorion by its mandible. The eggs are always laid on the under-surface of the leaf of the cauliflower and are covered with a fine wooly mass.

The Larva.—The freshly emerged larva moves over the leaf, gnawing small pits in it. It spins silk enabling it to maintain its position on the foliage. Later, the larva marches towards the cauliflower to settle down there. It constructs tunnels inside it devouring the entire flower. "Frass" is noticed scattered on the cauliflower, and this helps spotting of the pest in the field.

The larva undergoes six instars.

First stage.—The larva on emergence measures 1·06 mm. Its general body colour is white, the shape is cylindrical but tapering at the posterior end. The

larva later assumes a greenish colour on eating the foliages. The head is shiny black, it is big when compared to the body. The mouth-parts are pale brown in colour and maxillae somewhat paler.

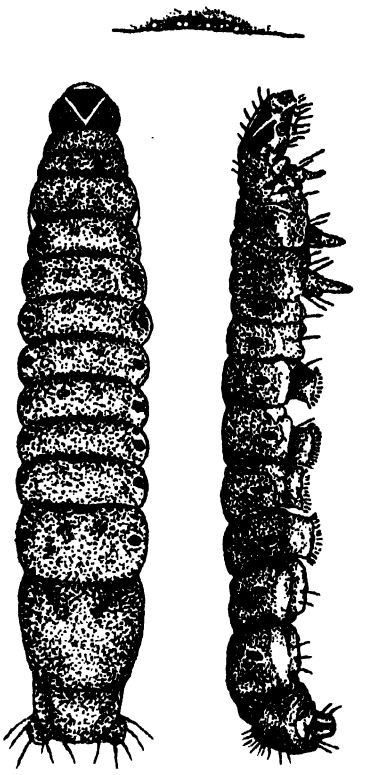


FIG. 1. *Upper*—Egg (side view). *Lower Left*—Larva (Dorsal view). *Lower Right*—Larva (side view).

Circular black tubercles occur on each segment and each tubercle is capped with long black hairs.

Second stage.—After the first moult the larva measures 7·30 mm. in length. The general body colour is olive green or pale green with a somewhat yellowish line on the dorsal side of the body. The head is pale or dark brown and presents a prominent triangular mark. The tubercles become more distinct. The thoracic shield is smoky. The distinctive feature is the presence of a prominent black spot on each side of the first abdominal segment.

Third stage.—After the second moult it measures 18·00 mm. in length. The general body colour is deeper than in the previous instar ; but the colour is variable, being dark brown, dark grey or almost black mottled with irregular spots. There are two black spots with yellow edges on the dorsum of meso-thorax and two similar ones on the meta-thorax, and two big black areas on the first and eight segments of the abdomen. Distinct light bands occur ; one across the first abdominal segment, and other bands run longitudinally.

Fourth stage.—After the third moult the length increases to 25·00 mm. No important changes in colour are observable.

Fifth stage.—After the fourth moult the length measures 37·60 mm. The transverse black band on the first abdominal segment and the longitudinal band on the larval body become faint.

Sixth stage (Fig. 1).—After the final moult the larva measures 43·30 mm. in length. The

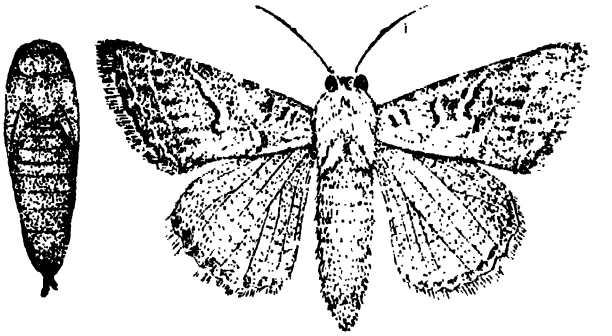


FIG. 2. *Left* Pupa (Dorsal view). *Right*—Adult (Dorsal view).

transverse and the longitudinal bands on the larval body fade away. Afterwhile the larva stops feeding. It now travels towards the soil for pupation under earth. Hereafter the larva shrinks in size, and the body is annulated. It now passes into the pupal stage. Prior to the transformation, the ripe larva emits a resinous substance which helps in building up a cell for pupation.

The Pupa (Fig. 2). The pupa measures 19 to 22 mm. in length including the hooks. It is 7 to 8 mm. in width across the fourth abdominal segment. The colour of a justly transformed pupa is green but as the age of the pupa advances the general body colour turns to reddish brown ; the abdomen is a shade lighter than the rest of the body. It tapers gradually towards the posterior end and terminates in two straight hooks. Of these one is more blunt and shorter than the other. The spiracles are prominent and darken in colour than the abdomen. They are round and raised above the surface. The antennae are comparatively long, reaching nearly the edge of the wing pad.

At the time of emergence, the pupal case splits open liberating the moth.

The Adult (Fig. 2).—The moth fly at dusk ; during the day time they hide in crevices or in dark recesses of the neighbouring trees. On account of its peculiar colouration, it is difficult to detect the moths especially when they rest on the bark of trees. If disturbed they fly to a long distance. They are attracted to light. The moth measures 38 to 40 mm. in wing expanse ; the body length is 19 to 22 mm. ; abdominal width 6 to 7 mm. The general body

colour is greyish brown. The fore-wing is full of ochreous lines and bars, running for longer or shorter distances along the veins and also runs obliquely. In the male moth the ochreous lines are more prominent than in the females. The male differs from the female in having a ochreous band on the lower edge of the fore-wing. The hind-wings are white, irredescent and the wing edges are dark brown with brown veins. The wing expanse is 30 to 32 mm. The thorax and abdomen are orchreous to light brown with tuft of hairs. The head is covered with brown tuft of scales.

Oviposition

Paring takes place one or two days after the emergence of the adult. It lasts for one to two hours. Generally coition takes place at night but sometimes during day time the adults are found in the conjugating stage. The oviposition usually occurs either early in the morning or just after the sun-set or in the night. As the time for oviposition approaches, the female becomes quiet. She then slowly lifts the tip of her abdomen and starts laying eggs. This process is repeated again and again until the eggs being laid in batches. The maximum number of eggs deposited by a single female is 578. The pre-oviposition period varies from 2 to 4 days.

The incubation period of the egg is 4 days. After hatching the active larva starts damaging the cauliflower attacking the leaves first. The entire larval period lasts from 18 to 20 days and the amount of damage thus can be conceived. The pupal stage lasts from 9 to 10 days. The adult can live from 16 to 24 days.

The life-history may be summarized as follows :-

TABLE I

Summary of the life-history of *Prodenia litura* on Cauliflower

Stages in life-history	Maximum (days)	Minimum (days)	Average (days)
Pre-oviposition period ...	4	2	3
Incubation period ...	4	4	4
Larval period	20	18	19·5
Pupal period	10	9	9·5
Life of adult moth ...	24	10	17
Number of eggs deposited per female	578	292	435

References

1. Bishara, I., *Bull. Soc. Ento.* Egypt., *18*, 228, 1934.
2. Basu, A. C., *Journ. Bom. Nat. Hist. Soc.*, *44*, No. 2, 1943.
3. Fletcher, T. B., Some South Indian Insect, Madras, 1914.
4. Janish, E., *Zool. Morph. Okol. Tiere*, *17*, 339, 1930
5. Raichoudhury, D. P. and Basu A. C., *Proc. 28th Ind. Sc. Cong.*, Benares, 1941.
6. Wilcock, F. C., Year Book *Khedivial Agri. Soc.*, Egypt, 1905.

PROFESSOR P. C. MAHALANOBIS, F.R.S.

THE recent election of Prof. Prasanta Chandra Mahalanobis to the Fellowship of the Royal Society of London is a fitting recognition of what he has been doing during the last 25 years for the science of statistics in general and its application to the study of Indian problems in particular.

Born in 1893, Prof. Mahalanobis graduated from the Presidency College, Calcutta, in 1912 and had a very distinguished career at Cambridge. He obtained Mathematical Tripos in 1914 and a first class in natural science, Part II, in 1915. During 1915-17, he was a senior research scholar of the King's College, Cambridge, and in 1918 received the Master's Degree of the Cambridge University. On his return to India, he joined the staff of the Presidency College as a professor of physics in the Indian Education Service, and also became lecturer of the Calcutta University. In 1941, he became the Head of the Department of Statistics, Calcutta University.

Although he had his early training in physics and began his career as a professor of that science, statistics has been his first love for nearly 30 years now. Descriptive statistics, as is well known, is a very old science, but analytic statistics as a separate branch of knowledge is of comparatively recent origin and came into being during the last quarter of the 19th century. The new branch of science, like most of the positive sciences, was born out of, and grew in response to, social and economic urge and finally developed into an abstract system of knowledge to be studied for its own sake by a few of the many men of science. The foundations of the new science were laid and the main outlines of the methodology developed, among others, by the late Prof. Karl Pearson and Prof. R. A. Fisher, both doyens of analytic statistics in England. Among the numerous other workers in this comparatively young science within the last twenty-five years which include Prof. Neyman of Poland, Prof. Hotelling of U. S. A., and Prof. Yates of Great Britain, Prof. P. C. Mahalanobis holds a distinguished position. On the purely theoretical side, the science owes him

significant developments in two important directions. Once different species of the same genus have been distinguished as such (by methods to which also he has made important additions), there still remains the problem of classifying them by ordering against some sort of scale. This he has tried to tackle with a fair measure of success, opening out in fact a vast field of work for statisticians and mathematicians for years to come. The second line of development, one with perhaps much greater socio-economic significance, is



PROF. P. C. MAHALANOBIS

concerned with the formulation of correct principles on which large scale sample surveys should be designed and the results interpreted so as to secure at minimum cost and with maximum precision any item or items of information about areas and populations as big as those that cover an entire province or even a country of the size of India. Here, as elsewhere, the methodology evolved out of his attempts to tackle the problems arising out of actual surveys he had undertaken at the request of the Central Government, the various provincial Governments and other non-official bodies and organizations.

Great as his contributions to the theoretical and practical aspects of analytic statistics are, the services he rendered in the direction of creating an Indian school of statistical study and research have been greater still. The Indian Statistical Institute which is the only organization of its type in India and of which he has been the Founder Secretary since 1931 owes its inception to him and expresses most eloquently his interest in, and concern for, the development of statistical science, both pure and applied, in India.

Professor Mahalanobis combines in a rather unusual manner passion for abstract science with interest in its applications, the academic detachment of a scientific worker with the social sense of a responsible citizen, the leanings and temperament of a recluse and savant with the actual habits of a big routine administrator. This rather unusual combination of slightly incompatible traits has not made life smooth for him personally, but it has brought his country a very rich harvest of varied activities. He has great interest in literature, philosophy, anthropology and various other social sciences.

Prof. Mahalanobis was associated with many progressive and cultural activities. He was the Honorary General Secretary of the Visva-bharati during 1921-31 and Honorary Editor of the *Visva-bharati Quarterly* during 1927-29. *Sankhya*, the Indian Journal of Statistics, of which he has been the editor since 1933, is a recognized periodical of high standard in the subject. He is a fellow of the National Institute of Sciences since its inception in 1934 and was president of the Anthropological Section in 1025 and of the Mathematics and Statistics Section in 1942, of the Indian Science Congress. He was awarded Weldon Memorial Prize in 1944, a singular and rare distinction shared by an Indian for the first time (See SCIENCE AND CULTURE, Vol. X, No. 3). He is the chairman of the Statistics, Standards and Quality Central Committee of the Council of Scientific and Industrial Research and Statistical Adviser, Statistical Bureau, Government of Bengal. Besides, he has served on several Government Committee set up from time to time to advise the Government on statistical issues. The session of the Indian Science Congress held early this year at Nagpur elected him as its General Secretary.

We wish him many more years of fruitful activity.*

* Based on materials kindly supplied by an ex-student of Prof. P. C. Mahalanobis.

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Notes and News

BOMBAY PLAN II

The second part of the plan of economic development for India, popularly known as the Bombay Plan and prepared by a number of leading industrialists of India, discusses the various problems connected with distribution and also the allied question of the part to be assigned to the State in a planned economy. Sir Ardeshir Dalal, one of the eight authors of the Plan, was unable to sign part II, owing to his appointment as Member for Planning and Development in the Government of India. The authors have drawn pointed attention to the gross inequality and disparity of income, which act as a serious hindrance in the development of a country's economic resources. In 1931-32, the authors state, one half of the total urban income was in the hands of less than 10 per cent of urban workers and 'even among the comparatively well-to-do class, whose annual incomes exceed Rs. 2,000 a year, 38 per cent of their number could claim only 17 per cent of their total income, while a little more than 1 per cent were in possession of as much as 10 per cent of their total income.' The authors believe that in any economic planning it is desirable in the best interest of the country to have enough scope for variations in income according to ability and productivity, but there should be adequate safeguard against gross inequality. The suggestions they have produced with a view to securing an equitable distribution of income include the imposition of death duties and other similar levies, the reform of the system of land tenures, decentralization of the ownership of means of production through widespread distribution of shares in joint stock companies, regional distribution of industries, and through the development of co-operative enterprises. They further advocate that a steeply graduated income tax would be the most direct and important method of keeping personal incomes within limits and preventing gross inequalities.

The creation of a minimum standard of living required for civilized existence is the main purpose of economic planning. To secure this, the authors propose two classes of measures: (1) those that would raise the general level of income and (2) those that would reduce the cost of living. The former involves (*a*) provision of full employment, (*b*) increase in efficiency, (*c*) improvement in urban and rural wages, (*d*) security of agricultural prices and development of multipurpose co-operative societies, and (*e*) reform of the land system, each of which is discussed in the memorandum. To reduce the cost of living, they suggest provision for free social services such as primary and middle school education, adult education and medical treatment, and essential utility services at low costs, such as electricity and transport. In addition to these services, there will be need for creating a national relief fund on the lines of the present famine relief fund, but larger in resources and in scope, to meet emergencies arising out of a failure of the monsoon, and hence, of crop, or any other national calamity. There should also be some provision for social security against such contingencies as sickness, old age, technological unemployment etc., and a comprehensive scheme of social insurance should be implemented for this purpose. This scheme cannot, however, be introduced at the outset, as it requires, for its success, the condition of full, or at least stable, employment for a greater part of the population, and also a reasonable level of average individual income.

The authors, while proposing taxation on such a large scale are, however, conscious of the possible abuse by the foreign imperial government of large powers derived from such taxation. In fact, the possibility of this abuse with its dangerous implications constitutes a powerful argument against heavy taxation under a government neither responsible to the people, nor wedded to a stated policy of full scale national development. The authors have, therefore, emphasized the creation of a responsible national government as the *prima facie* condition of the successful working of the Plan.

In elaborating the part to be played by the State in the economic organization contemplated in the Plan, the authors accept the democratic form of government and assume that planning is not inconsistent with a democratic organization. They have worked out their Plan on the supposition that Democracy permits of State intervention implicit in planned development but leaves enough scope and freedom to the individual to exercise his personality and initiative to the fullest extent. Co-ordination of general economic activity, management of currency and public finance, collection of statistical and other information, and adoption of legislation to safeguard the interests of the economically weak classes are usually recognized as the primary concern of the State. In addition to these, State intervention is now increasingly being sought in the direction of ownership, control and management of economic enterprises, and the authors have briefly indicated the nature of the State's functions in these directions.

In placing their views about the relation of State with the economic organization of a country, they have developed no new thesis, but have followed typical British economists, such as Professor Pigou, from whose writings they have quoted freely.

WANTED A WELL-DEFINED POLICY

THE speech delivered by Mr G. L. Mehta at the 18th Annual Session of the Federation of Indian Chambers of Commerce and Industry on March 4, 1945, in moving the resolution on Government's policy regarding post-war industrial development, has been significant from more considerations than one. His speech, we are afraid, may rudely shake the rosy optimism engendered to certain extent by the Government's big reconstruction talks. The various issues he raised concerning the future industrial development of India merit close attention. At the outset he drew pointed attention to the absence of a positive declaration by the Government of their policy with regard to industrial development after the war. The Government came forward with no categorical and unequivocal declaration that they would safeguard the position of industry and would stand by it and encourage its development for a specified period of time. Vague assurances regarding the liberalization of the tariff and protection policy have been given by high officials from time to time ; but these have encouraged no hope since the Government 'speak sometimes with as many as eight voices and we do not know which voice to give credence to at that time and in what respect.'

Mr Mehta strongly criticized the Hon'ble the Finance Member's remark in his budget speech that 'post-war development must mean and must continue to mean post-war development and by no magic or optimism can it be made to mean war-time development'. He cited the instances of Canada and Australia, the governments of which already evinced their attitude to lay the foundations of post-war development during war-time by and through the development of war industries. "In the very carrying of the burdens", said the then Australian Premier, "we are laying industrial foundations, opening up new resources, acquiring new skill and experience ; paradoxically enough, our war needs are likely enough in many ways to provide our peace opportunity." This spirit of working has enabled Canada to become today the second country in the world in the building of cargo ships, fourth among the world's air powers and the third trading nation in the world. Australia developed her steel and aircraft industry almost from a scratch. But not only India has not been able to build up one single key or heavy industry, her industrial development has been handicapped in many respects owing to difficulties of obtaining supplies of some essential raw materials, plant and machinery from abroad.

With regard to India's participation in any international agreements, Mr Mehta sounded a note of warning. The series of international conferences which are being held as the prospect of peace is drawing near may witness arrangements, understandings and agreements, commercial and otherwise, in regard to many matters, in which India will, whether with or without her wishes, be made a party. Mr Mehta said, "Our experience in regard to international agreements in the past has been very unfortunate. We have had to accept obligations, burdens and responsibilities under such international agreements while being denied the rights, privileges and benefits they confer." For instance, the proposed formula of the equal access of raw materials of the world contains the disquieting suggestion that the more industrialized countries will have abundant and cheap raw materials to the permanent disadvantage of the less industrialized. There is as yet no sign that the imperial powers are prepared to give up Imperial Preference. Furthermore, the fears of international cartels and combines are now as great as ever, and it is essential that the operations of such cartels, in so far as they affect Indian industry, should be carefully studied. Mr Mehta also discussed the role of State in industry in future, the problem of foreign capital working in India and various other topics. With regard to the dangers of foreign capital, he quoted a passage from a historical speech by President Wilson, which runs as follows: "A country is dominated by the capital invested in it. It is a fundamental idea that in proportion as foreign capital comes in and takes hold, foreign influence comes in and takes hold. Therefore, processes of capital are in a sense processes of conquest".

TUNGABHADRA PROJECT

THE Tungabhadra Project which was inaugurated on February 28, 1945 by H. E. Sir Arthur Hope represents the joint endeavour of the Governments of Hyderabad and Madras to eradicate famine from the Ceded Districts. The project estimated to cost Rs. 20 crores provides for the construction of a dam across the river Tungabhadra at Mallpuram, from which each Government will at present draw about 65,000 million cubic feet of water. The dam will be 150 ft. high and 8,200 ft. long, with ample provision for sluices and high and low level canals. The lake formed by the dam will cover an area of about 140 square miles and will have a capacity of 112,000 million cubic feet. The cost of the dam would lie in the neighbourhood of Rs. 7 crores, while the total canal system of 440 miles would involve an expenditure of about Rs. 6 crores. Power will also be developed out of the supplies from the reservoir. The

execution of the project, it is reported, will take about eight years.

The project would primarily benefit the dry and arid northern portions of the Bellary and Kurnool districts which frequently suffer from failure of crop and hence from famine. The net revenue from irrigation is estimated at about Rs. 12 lakhs and power revenue at Rs. 8·08 lakhs. The annual value of crops, both dry irrigated and wet, has been estimated at Rs. 5 crores. The project will be primarily a dry irrigated one and has been conceived with a view to extending its benefits over as large an area as possible.

The possibility of harnessing the waters of the Tungabhadra, which run to waste to the sea, was always before the Government since the time of Sir Arthur Cotton. The Famine Code Revision Committee of Madras, in their report issued in 1938, demanded the early execution of the Tungabhadra project as the solution of recurrent famine in these districts. The present initiation of the project is largely due to the co-operation of the Governments of Hyderabad and Madras in their common effort to utilize the waters of the Tungabhadra for the benefit of their people. Rao Bahadur N. Govindaraja Ayengar, chief engineer for Irrigation, pointed out in his statement that this was the first time in the history of India when two autonomous units, a province and a State, co-operated in a joint endeavour of this magnitude for the common good of their two peoples. Narrow provincialism has often stood in the way of initiating hydraulic and irrigation schemes of inestimable value. Let us hope that the example of the Nizam and Madras Governments should be followed in future by other provincial Governments whenever need for such joint action in the interest of the people would arise.

DIVISION OF HIGH-POLYMER PHYSICS

THE Council of the American Physical Society, according to a report of the *Journal of Applied Physics*, has recently authorized a new Division of High Polymer Physics under the Society. The object of the Division, as stated in the by-laws, is to secure 'the advancement and diffusion of the knowledge of the physics of high-polymeric materials of any kind. Illustrative examples include rubber, textiles, plastics, pulp and paper, paints and varnish, and leather.' The scope of the Division is declared to be sufficiently broad to include fundamental as well as technical problems of high-polymer research physicists working in academic, industrial and Government laboratories.

The institution of this Division is a clear indication of the rapid development of high-polymer physics which concerns the study, by physical principles and techniques, of such substances as rubber, textiles, and plastics. Work in this specialized field has proceeded so fast under the stress of war that text and reference books have failed to keep pace with the development, leaving the research workers to fall back on personal discussion, technical literature and such other means for exchange of information. Research directors and scientific workers of this field increasingly regarded the available opportunities for exchange of information as insufficient and pressed for the creation of a division in the American Physical Society to fulfil their needs. At a meeting held towards the end of 1943, the Council of the Society fully considered the case presented by the physicists engaged in high-polymer research for the establishment of a division and approved of its creation. The President of the Society subsequently appointed an organizing Committee consisting of Council representatives headed by Dr K. K. Darrow as chairman and members of the Society sponsoring the new division. The Division which had already started work since its authorization in 1943 was formally established at an inaugural meeting held on June 23 and 24, 1944. Any Fellow or Member of the American Physical Society may enrol in the Division, while for other interested scientists and research workers, the Division provides an associateship with all facilities except the rights to vote and to hold office.

QUININE IN INDIA

AT a recent meeting of the House of Commons, according to a report of *The Chemical Age*, Mr L. S. Amery, in reply to a question by Mr R. Sorensen, stated that 491½ million tablets of synthetic anti-malarial drugs were shipped to India in 1943. The total shipment of the same drug in 1944 amounted to 632½ million tablets, in addition to 1,000 lb. of totaquina. Quinine stocks in India in April, 1944 stood at 244,000 lb. He further stated that India was producing more quinine than she had been doing in the pre-war period, which was about 90,000 lb. a year. He also gave out that pre-war consumption of quinine was about 200,000 lb. a year, while that of synthetic anti-malarial drugs was negligible.

It appears that Mr Amery tried to present a very bright picture of the supply of quinine in India. It is curious that despite such improved supply of quinine, the mortality rate due to malaria has assumed alarming proportions during recent years and has surpassed previous records. Competent authorities have ascribed the high incidence of malaria with its heavy toll of life to serious shortage of quinine. The figures which Mr Amery produced in course of the parliamentary debate are utterly without any significance, as these do not tell us the

amount available for civilian consumption. Moreover, the figures are misleading. This is how the Secretary of State keeps the people of his country informed about affairs in India.

MAHARAJA ANUPSINGHJI AS AN ASTRONOMER

In the February 1945 issue of the *Bikaner Bulletin*, K. Madhava Krishna Sarma, curator, Anup Sanskrit Library, describes the astronomical work of Maharaja Anupsinghji of Bikaner, who flourished in the seventeenth century A.D. The great scholar Maharaja who patronized all branches of learning, including Kavya, Jyotisha, Ayurveda, Dharmashastra, Kamashastra, Mantrashastra and Astronomy, was himself a learned astronomer and made important contributions to this science. His monumental work 'Anupasimha-Karana' which ranks in importance with the astronomical work 'Rajamiganka' of the famous Bhoja of Dhara deals with the calculation of planets. His famous work and the astronomical instruments belonging to him are now available in the Anup Sanskrit Library. The Maharaja gathered round him a number of eminent astronomers of his time, such as Manirama Dikshita, Virasimha Ganaka, Hoshinga Rama Bhatta and Kashiraja. It may be noted that the 'Arya-Siddhanta-Tulya-Karana' (written at the age of sixteen) and 'Anup-Mahodadhi' of Virasimha, the 'Anup-Vyavahara-Sugara' of Manirama and the 'Anup-Megha-Mala' of Hoshinga Rama bear testimony to the excellence attained by Hindu astronomy.

STUDY OF THE UPPER AIR

Two types of radio-sonde have recently been developed by the Indian Meteorological Department for the study of upper air, one at the Upper Air Office at Delhi and the other at Upper Air Section of the Meteorological Office at Poona. The radio-sonde is designed to send radio signals of the pressure, temperature, and humidity, which can be automatically recorded by receiving apparatus on the ground. The instrument is light, weighing only a few ounces, and is tied to a balloon filled with hydrogen which carries it to upper air, usually to a height of 8 to 10 miles. The observations are telegraphed to the various forecasting offices and enable them to get an accurate picture of the physical processes affecting weather and to estimate the course of its evolution. This knowledge is of great importance in the issue of weather warnings to aviators, irrigation engineers, agriculturists and the general public. It is reported that all the parts of the instrument excepting the wireless valves are now being made in the departmental workshops on a mass scale. A few selected stations have made arrangement for the daily sending of balloons equipped with radio-sonde to sound the upper air.

ECONOMIC MINERALS BUREAU

The Council of the Geological, Mining and Metallurgical Society of India has recently circulated a letter, proposing the establishment of an Economic Minerals Bureau on the lines of the present Imperial Institute in London, with which the Imperial Mineral Resources Bureau is incorporated. The Bureau will maintain (*a*) an office to supply accurate mineral and metal facts relating to the Indian mineral and metallurgical industries, including cement, pottery and glass-making, (*b*) a bureau for the collection of information and data relating to the geological, mining and metallurgical industries throughout the world for Indian enquirers, (*c*) an office for registering and recommending staff for geological surveys, mineral prospecting and opening ore deposits or starting metallurgical works, (*d*) a laboratory for making assays, chemical analyses and physical tests quickly, cheaply and reliably in regard to mineral substances for industrial purposes, and (*e*) an advisory staff or committee or council to control the above offices, bureau and laboratory and advise on the mineral development on safe and sound lines.

The total cost of establishing such an Economic Minerals Bureau has been estimated at about Rs. 3·5 lakhs, of which capital expenses will account for Rs. 2,75,000, rent and salaries, Rs. 50,000/- and running expenses, Rs. 25,000/-.

Many individuals and firms have often felt the need for such an organization, which is now further reinforced by the prospect of a planned development of India in the post-war period. It gives us much satisfaction to think that the Society has applied its mind to the problem of establishing an organization that should act as a clearing house for geological, mining and metallurgical information and at the same time provide scientific assistance in the form of making assays, chemical analyses and physical tests.

METAL INDUSTRIES

At the first ordinary annual general meeting of the Jaipur Metal Industries Ltd., held on 28th February last, Mr R. H. Kamani pleaded for the development in this country of our mineral resources of non-ferrous metals like copper, zinc, lead, tin, etc. India will have to depend on outside sources for her supplies of these metals either in the form of virgin metals or as scrap metals. It should be one of the primary objects of our national policy to develop the mining of non-ferrous metals in the country itself as far as possible.

The establishment of a large non-ferrous refining and manufacturing industry in the country will provide the necessary market when the production of virgin metals has been developed. The non-ferrous manufacturing concerns should be given every facility

and preference for the import of non-ferrous virgin metals and scrap from abroad, which can be used by the indigenous manufacturing concerns, and the import of finished or semi-finished goods which would compete with these industries should be discouraged.

Before the war, India was exporting most of the non-ferrous scrap to Germany and Japan. This policy will have to be changed if India is to develop her own non-ferrous industry, and the export of such scrap should be either prohibited or restricted by the imposition of a heavy export duty. It is to be hoped that the Government will soon see their way to altogether abolish, or reduce considerably, the import duty on non-ferrous scrap, and also levy a much lower duty on import of virgin metals like copper, zinc, etc.

Rajputana is rich in non-ferrous mines, of which the copper deposits of Jaipur and zinc deposits of Udaipur State are well known. The development of these deposits deserves an early attention. The Jaipur Metal Industries Ltd. is the first in India to be successfully manufacturing arsenical copper rods which are required by the railways for locomotive boilers.

MICROFOSSILS AND PROBLEMS OF SALT RANGE GEOLOGY

PROF. BIRBAL SAHNI, F.R.S., since he delivered his Presidential Address to the National Academy of Sciences, India, at Hyderabad, in December 1943 (See SCIENCE AND CULTURE, November, 1944, p. 199), has further evidences to put forward in support of tertiary age for the Punjab Salt. In his Presidential Address to the National Academy of Sciences at Poona in December last (*Proc. Nat. Acad. Sc. Ind. 14*, 1944), Prof. Sahni discussed the results of recent investigations. Problem of the age of Punjab Salt has now received the serious attention of scientists, of geologists in particular. The presence of microfossils in the rock salt and kallar in the salt mines of Khewra and Warchha, which has been amplified and corroborated by repeated discovery of similar microfossils in dolomite and in the oil shales at both these places, is doubtless a simple and direct proof of a post-cambrian age for this series. Although a great majority of these microfossils (coniferous wood fossils) could not be referred to their genus and species, their repeated occurrence at widely different localities and in different members of the series is a strong evidence against a cambrian or a pre-cambrian age.

In view of the great practical as well as scientific importance of the problem, a field party deputed last November by the Geological Survey of India and by the Burmah, Attock and Anglo-Iranian Oil Companies paid a special visit to critical sections near Khewra, Warchha and Sakesar to re-examine the field evidence in the light of the fossil data. Their unanimous verdict is that an eocene or later age for the Saline Series is irreconcilable with the field evidence and that the Series is cambrian or older in age. In a letter to *Nature* (in the press), they (Coates, Crookshank, Gee, Ghosh, Lehner and Pinfold) have further stated that they have at present no clear explanation to offer on the occurrence of minute plant remains of post-cambrain age in dolomites and oil shales, as discovered by Prof. Shani.

Sahni's researches point very strongly to a tertiary age of the Series, supporting the idea of Koken and Noetling that the junction of the Saline Series with the overlying palaeozoic beds is a tectonic one, involving an immense overthrust fault.

Prof. Sahni's suggestion for research into problems of stratigraphical work in controversial and disturbed areas in general by microfossil technique, radio-active determinations, magnetic orientation of rocks etc. deserves careful attention.

AGRICULTURE AND ANIMAL HUSBANDRY IN INDIA

A PLAN for the development of agriculture and animal husbandry in India, prepared by a special Committee of the Imperial Council of Agricultural Research (with Sir Pheroze Kharegat as its Chairman) and approved by its advisory board, has the immediate object of increasing production by 50 per cent in the next 10 years and ultimately by 100 per cent in 15 years. This is not a post-war plan but one which has been taken in hand in connection with the "Grow more Food" campaign and will merge in course of time in post-war plans for general betterment.

A capital expenditure of Rs. 1,000 crores, according to pre-war costs, (on the basis of present costs, it is likely to increase to about Rs. 2,000 crores) and a recurring annual expenditure of Rs. 25 crores are provided. This amounts to an average total expenditure of nine annas per acre per annum, when all the cultivable area has been brought under cultivation.* Out of over 6,00,000,000 acres of such area, nearly 25,000,000 are uncultivated or fallow. The suggested production targets include 10 per cent increase in cereals, 20 per cent in pulses, 250 per cent in fats and oils, 100 per cent in vegetables, 50 per cent in fruit, 300 per cent in milk, and 300 per cent in fish and eggs.

The aim of the plan is to provide enough food of the right kind for every individual and effect a higher standard of living. The plan thus put forward is not a complete scheme but only a skeleton as to the lines along which work should be undertaken and is

* The Bombay Plan provides for an expenditure of Rs. 1,245 crores to achieve an increase of 130% in agricultural productions in 15 years.

meant for those who have to do the actual planning. Much of the work will devolve on Provincial Governments, and the Centre can only help by co-ordinating and finding out part of the money. Thus, of the recurring expenditure of Rs. 25 crores, the Central Government would bear Rs. 2½ crores. This represents an average of less than one rupee per acre on the present total area under cultivation or of less than twelve annas per acre, if the whole of the acre now recorded as cultivable waste can be brought under cultivation.

The most important requirement from the point of view of the agricultural department is trained staff. A scheme of intensive short-term training of agricultural staff has been suggested to the provincial Governments, and arrangements are in hand to start training courses at the various agricultural colleges according to the needs of the provinces. Other important points include both long and short-term possibilities *e.g.*, the provision of irrigation facilities, bunding and drainage, manure, improved cattle, improved seeds, and spread of better methods of cultivation.

Under manure, the plan estimates that 2½ million tons of nitrogen are required annually. Production can be raised by 10 to 15 per cent by the use of better seed, the best rotation crops and the raising of two crops instead of one. A seed farm should be set up in every district to produce pedigreed and to arrange for their multiplication, storage and distribution.

There is scope for tractor cultivation, and some of the prejudices against it are unwarranted. But the use of tractors and other costly mechanical equipment implies large farms to be established through either co-operative farming or consolidation of holdings, a reform long overdue.

For marketing, villages should be organized to be co-operative, maintain quality and sell the surplus produce jointly. The Government could help by guaranteeing to cultivators assured markets promising a reasonable price.

In cattle improvement, there is a need for improved methods of feeding, breeding, management and disease control. Surveys should be taken in hand for schemes for reclamation of waste lands and the maximum ultilization of water resources.

There now exists a big gap between scientific knowledge and its dissemination. It is suggested that every *tehsil* and district should have an agricultural association, and every village a guide who will act as a link between the technical experts and the cultivators and will be the departmental correspondent for his village. The village guide will have to be in knowledge, status and equipment something more than a village chowkidar.

It is further suggested that the Imperial Institutes of Agriculture and Veterinary Research should specialize in work of a fundamental nature and their programmes should be co-ordinated with those of provincial research institutions and universities.

Regional or provincial research stations for each commodity and experimental farms in each division are also recommended. That should help in spreading out scientific work and therefore knowledge.

Central commodity research stations should be established, apart from cotton, jute, tobacco, sugarcane, tea, coffee and rice (now about to be established), other foodgrains, vegetables, potatoes, fruits, medicinal plants, plantation products, oilseeds and grasses. Of these rice, oilseeds, potatoes and vegetables seem to be the most important at present. Each such station should be linked up with an Indian central committee for that commodity and each central research station should be supported by the necessary regional research station and substation. The Federal Council of Agriculture and Animal Husbandry should co-ordinate the work of the commodity research station. The plan is now under examination by provincial Governments.

INDIAN CENTRAL RICE COMMITTEE

A BILL providing for the creation of a fund to be expended by a committee specially constituted for the improvement and development of the cultivation and marketing of paddy and of the production and marketing of rice and rice products and all matters incidental thereto is now pending the approval of the Central Assembly.

Introducing the bill, Mr Tyson said that the funds for the committee should be provided by the levy of a cess not exceeding a rate of six annas per ton on all paddy which is hulled in power mills in British India. Only 27 per cent of rice produced in India was brought to mills, and the cess worked out at less than one pice per maund or one anna per annum to each member of a rice-eating family. It was expected to raise Rs. 24 lakhs a year in this way and this sum was twice the income of the Imperial Council of Agricultural Research.

The bill had been circulated to provincial Governments, and all except Bihar had approved them. Bihar stated that rice was not a valuable commercial crop and the cost of research for its improvement should be supported by ordinary revenues. That was the opinion expressed also by several members of the assembly who raised serious objections, and the bill was thus circulated for eliciting public opinion. The re-drafted bill will shortly be introduced in the Assembly.

The main object of the bill is to put rice research, development and technology on a more permanent basis than it stands at present. The deficit production of rice in India, coupled with the increase in

population in the rice-consuming areas, can be balanced by increasing the acre outturn of rice, and this is only possible by intensive research in all aspects and making the results of such research available to the rice-growers. As a result of the investigations of the Imperial Council of Agricultural Research and by the provincial agricultural departments only 6 per cent of the rice area has so far been covered by improved varieties.

The committee when constituted would utilize the fund to defray expenditure involved in (*a*) undertaking, assisting or encouraging agricultural, industrial, technological and economic research, (*b*) supplying technical advice to growers and owners of mills, (*c*) encouraging the adoption of improved methods of cultivation and storage, (*d*) promoting testing, and distributing improved varieties of seeds, (*e*) aiding the control and destruction of insect and other pests and diseases of paddy and rice both in the field and in storage, (*f*) promoting the improvement of the marketing of paddy, rice and rice products, including the adoption of standard grades for paddy and rice, (*g*) collecting statistics from growers, dealers and millers on all relevant matters and improving forecasting of crops, (*h*) maintaining institutes, farms and stations as necessary, and (*i*) doing of such other things as may be necessary for carrying out the purpose of the act.

The committee is proposed to be formed on lines similar to those of the Indian Tea Cess Committee (1903), Indian Central Cotton Committee (1923), Indian Lac Cess Committee (1930), Indian Coffee Cess Committee (1935) etc. The committee will include representatives upto a maximum of 51 members, of which 14 will represent rice growers, 14 the rice industry and trade, 5 persons nominated by the Central Government and the rest forming the technical officers of the provincial and central departments of agriculture with the Vice-chairman, Imperial Council of Agricultural Research as its President. The committee would start functioning before another rice season begins this year.

In our opinion, while supporting the immediate formation of a committee to carry out the provisions of the bill, we would point out that the committee as proposed to be constituted has no representatives either of the consumers or of universities or similar non-official organizations. Further, rice being the staple food (and not a commercial crop), Government should at least provide half of the proposed funds for the committee thereby reducing the rate of the proposed cess.

JAYKISSEN MUKHERJEE GOLD MEDAL TO MR D. N. WADIA

The Indian Association for the cultivation of Science has recently conferred its highest award, the Jaykissen Gold Medal, to Mr D. N. Wadia, late of the Geological Survey of India and now mineral adviser to the Department of Planning and Development, Government of India. On the occasion of the award, Mr Wadia delivered a lecture on 'India's Petroleum Resources' in the Association's lecture hall before a distinguished gathering. A short summary of his interesting lecture will appear in our next issue.

ANNOUNCEMENT

We are glad to inform that Mr. P. K. Dutt of the well known firm of Messrs. Adair, Dutt & Co., Ltd. has placed a further sum of Rs. 5,000/- at the disposal of the Adair, Dutt Research Fund Committee. The total sum up to date amounts to Rs. 17,000/- only.

SCIENCE IN INDUSTRY

WEALTH FROM THE SEA

The difficulty of access to raw materials in land has driven the scientists to seek them in the vast expanse of the air and the sea. This is particularly the case in times of global wars such as the present one. The German chemists tapped the resources of the air to prepare nitric acid needed for the manufacture of explosives in World War I; the Allied chemists are now extracting magnesium from the sea for air-craft construction to win World War II. In fact the *economic* importance of air and sea as potential sources of indispensable materials is a new knowledge brought on by the impact of war. In a note in *The Scientific Monthly*, January 1945, Dr A. M. Low, British Consulting Engineer, has given an account of a number of important chemicals that have been successfully and economically extracted from the saline waters of the sea, and of others whose economic extraction, although not immediately possible, is likely to materialize in the near future. These substances include magnesium, bromine, potassium, phosphorus, copper, iodine, arsenic and gold.

The success attending the extraction of magne-

sium from the sea has, however, been the most spectacular. Magnesium chloride is present in sea water to the extent of 1 part in 800. Dr Low who concentrates mainly on the progress made in Britain reports that two plants were built in Britain, handling 11,000,000 gallons or more of sea water every day. The water is pumped into the plant through large pipes, filtered and then passed to a tank where the finest particles of insoluble matter are removed. It then passes to precipitation tanks for treatment with finely powdered lime. In practice, a mixture of lime and magnesium oxide obtained by calcining dolomite is used in place of pure lime. One plant in the U. S. A., it is reported, makes use of crushed oyster shells taken from the adjacent sea-bed and previously calcined into lime as a precipitating agent. Lime reacts with magnesium chloride dissolved in the sea water and produces magnesium oxide in suspension, which is filtered off and subjected to well-known reduction processes to obtain magnesium metal. The extent of the progress in the extraction of magnesium during recent years may be realized from the fact that it now incurs a cost of less than 20 cents a pound against $4 a pound 30 years before.

Bromine is another element of which the sea happens to be an important source. It is present to the extent of 1 pound in every 4,000 gallons. Bromine finds an important use in the manufacture of "anti-knock" fuel for which a lead compound dissolved in ethylene bromide is the key-substance. Its extraction from the sea water calls for exact chemical measurements, and methods have been so perfected in the U. S. A. that a single plant can now easily handle 60,000,000 gallons of sea water daily.

Dead sea, with its estimated potash reserve of 2,000 million tons and with the prospect of this amount being maintained more or less constant by the rivers flowing into it, offers a potential source of this substance. Methods of extracting potash from the sea are now available, but these require further improvement before manufacture on a commercial scale proves economic.

Gold is yet another element recoverable from the sea where it is present to the extent of one part in 1,000 millions. But even this amount far exceeds the quantity mined from the earth within the historic times. Search is going on for a practicable method of extracting gold from the sea as none exists up till now. But the difficulty with gold is that as soon as it begins to be available in plenty gold is no longer gold but lapses into an element with certain special physical and chemical properties.

CHARCOAL FROM INDIGENOUS KILNS

INDIAN Forest Leaflet No. 56, issued by the Forest Research Institute, Dehra Dun, contains results of investigation on the quality of 37 species of charcoal obtained from different types of indigenous kilns. It is well-known that the factors which determine the quality of charcoal are moisture, ash, volatile matter, fixed carbon and density. In determining these factors, sample from a particular lot was taken, crushed to a coarse powder and thoroughly mixed. A portion of this crushed charcoal was further powdered to enable it to pass through 60 mesh sieve and finally cleaned, washed and dried at the oven temperature of 105-100°C. The ash content, the amount of volatile matter, fixed carbon content etc. were then determined in the usual way, of which the results are indicated in a chart. It is found that the type of kiln and the selection of locality certainly influence, though to a limited extent, the quality of the charcoal as far as it depends on these factors. The temperature at which the charge is carbonized is by far the most important factor in deciding the quality, and the general conclusion is that almost any type of kiln can produce charcoal of good quality provided care is taken to carbonize the charge at regulated temperatures.

POLYTHENE—THE NEW PLASTIC

IN a recent issue of *Endeavour*, Dr J. C. Swallow, of the Imperial Chemical Industries, gives an interesting account of polythene, the simplest synthetic thermo-plastic. Polythene is obtained by the polymerization of ethylene under high pressure and is largely the outcome of recent researches on high-pressure chemistry. Although plastics containing the vinyl group were developed previously, ethylene—the simplest of the series—could not hitherto be made to yield anything except short-chain oils. The study of the effect of high pressures on chemical reactions by Conant, Cohen and other workers opened a new field of investigation, which rendered possible the examination of gas reactions at pressures of several thousand atmospheres. The application of the new high-pressure technique has led to the polymerization of ethylene into a plastic composed of long methylene chains (CH_2-CH_2-CH_2-CH_2-) of 1,000 units or more, which is polythene.

The new plastic has a very low solubility in most organic solvents, which, however, increases fairly rapidly between 50—70°C. At ordinary temperatures hydrochloric and nitric acids and 50 per cent. caustic soda have no effect on it, but chlorosulphonic acid strongly attacks it. Above 100°C, it is attacked by nitric and sulphuric acids. Ozone affects it, but only to a limited extent. At higher temperatures, polythene is oxidized in air, but oxidation can be altogether prevented by introducing anti-oxidants.

On the physical side, polythene possesses crystalline structure having orthorhombic symmetry. Its mechanical properties bear close resemblance with

those of other polymers such as nylon, the vinylidene chloride polymers, and the natural products gutta-percha and balata. On the application of tension, polythene separates into two regions, drawn and undrawn, marked by definite shoulders. This behaviour under tension is of considerable scientific and technical interest. The changes which occur when polythene is subjected to tension have been studied under polarizing microscope and by X-ray diffraction method and have revealed several interesting features.

Industrial applications of polythene include its growing use as a dielectric in the field of electrical engineering and as a suitable material for various purposes in which chemical resistance is important. The low power factor and low water absorption and permeability have particularly recommended it for telecommunication cables. Its use as a possible insulant for high voltage cables has also been suggested. A number of British firms have already undertaken to manufacture various types of high frequency cables with polythene insulation and submarine cable core insulated with polythene plasticized with polyisobutylene.

Large flawless mouldings and tubings have been made out of polythene by applying the technique of extrusion moulding. Extrusion moulding which consists in injecting the plastic by means of an extrusion machine has been possible with polythene, since above its melting point it is a liquid which can be conveniently pumped at comparatively low pressures. Polythene powders and films have also been prepared for specific uses.

NON-DRYING IMMERSION OIL

The Review of Scientific Instruments, August, 1944, reports the development, by the Fisher Scientific Company, Pittsburgh, of a non-drying microscope immersion oil which may be used in place of cedarwood oil for high magnification work. The new oil has the same refractive index ($1{\cdot}5150 \pm 0{\cdot}0002$) as cedarwood oil, but has a number of distinct advantages over the latter. It is much less corrosive inasmuch as it has an acid number of 0·2 as against 60 for the cedarwood oil. It does not attack glass or metal parts of objectives or Canada balsam, for does it affect the polished surfaces. Further, the new oil remains 'wet' for a much longer time and can be readily removed with a piece of cotton or cloth when the objective or slides require to be cleaned. Long standing and exposure to air do not change its refractive index.

There are two grades of the new oil, one with high viscosity and the other with low viscosity ; their other properties are, however, identical. The heavy oil which has nearly the same viscosity as cedarwood oil is suitable for use at higher temperatures or for instruments used in tilted or horizontal position. For ordinary uses, however, the light oil may be preferred and, if necessary, the two grades may be blended to obtain a grade of any desired viscosity.

LATEX-BEARING PLANTS OF INDIA

K. Budhiraja, Rubber Chemist and R. Beri of the Forest Research Institute, Dehra Dun, have summarized the results of their investigations on the indigenous sources of rubber, in Indian Forest Leaflet No. 70 (1944). They have examined 150 latex samples, covering six families, and 46 species with a view to discovering the possible, rubber yielding woody plants in India. With the exception of *Cryptostegia grandiflora* (see Science and Culture, Vol. X, Pp. 200) none of the species have been found to contain high proportion of caoutchouc with proportionately low resin, but a few species, *e.g., Palaquinum (Dichopsis) ellipticum, Madhuca (Bassia) latifolia, Ficus glomerata, Wrightia tinctoria, Tabernaemontana heyneana, Wrightia tomentosa* and *Poinsettia pulcherrima,* though they have high resin content, have also 15% or more of rubber and might therefore, find some use where rubber content of more than 10-30% is not required as for example, in code wire insulations, jar rings, floor coverings, ground sheets, coating to rope soled shoes, adhesives, etc. especially on dilution with pure rubber.

The pamphlet in addition not only gives an account of the history of *Ficus elastica,* and *Hevea brasiliensis,* but also remarks on the important sources of natural (commercial) rubber from *Parthenium argentatum* (U. S. A.), *Taraxacum Kok-saghyz* (U. S. S. R.) and *Landolphia Kirkii* (S. Africa) at the present time. The latter are neither indigenous to India nor they grow in countries from where the rubber could be made available to India.

Following the standard method of analysis the rubber and resin content in the latex of the 150 samples investigated are given in a tabulated form.

RUBBER YIELDING PLANTS

GEORGE T. VERGHESE and G. T. KALE

RUBBER is defined as tough, elastic substance, so named because of its ability to rub out pencil marks. It is not known precisely who named it, or when it was named. The diversity of sources, clime or country, and the development of manufacturing processes made little difference to this basic name. It was called "India Rubber" because it was first obtained from a country which Columbus thought to be India. It was called "Fine Para" (pronounced as 'Pah-rah') and "Para Rubber" after the city in Brazil, 'Pah-rah' from where rubber has been obtained in large quantities. Such trade names with different prefixes sometimes indicate the source of the product. Thus, African-, Madagascar, Lagos-, Ire'-, or Silk-, from Funtumia (Kickxia, Blume) or *Funtumia elastica,* Stapf, or Landolphia, Beaur ; Bolivian-, Columbian-, and Virgen-, from *Sapium* P. Br. ; Borneo-, from *Willughbeia,* Roxb ; Ceara-, from *Manihot glaziovii,* Muell.-Arg. and Manicoba-, from other species of the same ; Chilte-, from Cnidoscolus spp. ; Central American-, Panama-, Mexican-, or West Indian-, from *Castilloa,* Cerv. ; Ekanda-, from *Raphionacme utilis ; Mangabeira-,* or Pernambuco-, from *Hancornia speciosa,* Games-, Indian-, from *Ficus elastica,* Roxb ; Mgoa- from *Mascarenhasia elastica,* K. Schi. ; Potato- from *Euphorbia rhipsaloides* . Thina-, from *Loranthaceae,* spp. ; and so on. These rubbers are generally classified as "Wild Rubber". Rubber is also called Caoutchouc (French), supposed to be derived from the original South American word "Cahuchu", meaning weeping tree. Other languages have similar sounding names, for example, Kautschuk (German), Cauccio (Italian) Caucho or Cauchuc (Spanish), Kauchuk (Russian).

The early history of *Hevea* rubber is well-known. Rubber was known and used in the New World and Southern Asia long before it was re-discovered by Europeans. In this connection the names of Columbus (1493-1507, Second Voyage), Petro Martyre d' Anghiera (1521), Salahan (1529), Oriedo Y Valdez, (1535), Tordesilla (1601-15), Jaun de Torquemada (1615), and finally Marie de la Condamine who led the first expedition of the Academy of Paris (1735-1751), are often cited. During the 125 years after the date mentioned last no work of any significance was done on the subject, and it required the initiative, sagacity and foresight of the scientists of a Colonial Power to send an expedition in 1875-76 conducted by Henry A. Wickham (later Sir Henry Wickham) and financed by the Government of India. The growth of rubber plantation industry in Ceylon, India, and the Far East can be traced to the generosity of the India Government assisted by the Kew Gardens. The names of the Marquis of Salisbury, then Secretary of State for India, Sir Clements Markham, Sir Joseph Hooker and Mr Cross are worthy of mention in this connection. Wickham proved a very lucky and successful collector of seeds, and out of the 70,000 seeds he sent from a table land in the upper Amazon Valley to Kew, 2,700 germinated ; as the foundations of the tropical and subtropical agriculture were being laid at that time, 2019 seedlings were sent to Ceylon, and thence to Singapore and elsewhere in Malaya a year later, and then to Coonoor Estates in S. Malabar, and to Periyar Estate in Travancore. Some of the original trees are said to be still existing at Peradeniya in Ceylon. "*Aux grands hommes la patrie reconnaissante*", and it was an exceedingly fortunate accident that Sir Henry Wickham lived long enough to see the enormous expansion of the fruits of the early experiment of collection and trans-plantation. He died in 1930.

Though natural rubber is generally obtained from the latex of plants, not all the latex-bearing plants are rubber-yielders. Plants containing rubber occur in a number of very diverse natural orders: Euphorbiaceae, Moraceae, Compositeae, Asclepiadaceae, Araceae, Sapotaceae, Apocyanaceae, Alismaceae, etc., (Appendix I). The latex, either white or coloured, is present in special tubes or cells of the tissues in several or all the organs of the plant. Many latices do not contain rubber or allied substances, and it was believed till recently that the latices obtained from plants in cold and temperate zones were especially lacking in rubber. According to the various reviews and articles appeared on the subject the number of plants from which rubber has been obtained exceeds 400. In the present article it is intended to deal with, besides *Hevea brasiliensis* Mull.-Arg., the world's chief source of plantation rubber for the past several years, a few rubber plants which have attained prominence in recent years.

Hevea brasiliensis Mull-Arg., as a rubber yielder has displaced not only all other species belonging to the great family of Euphorbiaceae, but on account of the excellence of its rubber and its easy response to scientific methods of cultivation and manufacture, has come to establish itself as the king of rubber plants. Hevea (pronounced as Heev'ea), as its specific name indicates, is a native of Brazil and is the source of the best coutchouc ("Pah-rah" rubber). Its habitat falls within 10 degrees of the equator, and it thrives best in hot and humid climate up to

an elevation of about 1500 ft. above sea level. The average temperature that favours its growth is about 80°F., and the average rainfall about 80 inches per annum. Attempts were made with some success to grow it in rather dry climate, and also at elevations of about 2500 ft. above sea level. But growth under these conditions was slow, and yields were poor. In favourable environment the trees grow to about 50-100 ft. in height, and about 8-10 ft. in girth. They have smooth petiolate, and deciduous leaves in clusters of three. The deciduous nature of the leaves is mainly controlled by the precipitations, and the trees "winter" losing their dense foliage. Both male and female flowers are found in the same inflorescence, the axes of the latter being terminated by female flowers which are less numerous than the male ones on the same panicle. The androecium has two whorls of five sessile anthers each. The gynoecium consists of a tri-locular ovary with three style-less stigmas. In the East the fertilization has been found to be poor and defective. The fruit has a fleshy tissue on its outside, and when this gets dried up, dehisces violently with a loud report, shooting out its three seeds. The seeds are rich in an oil which does not appear to have been fully exploited. The presence of oil in the seeds is taken to be harmful to their germination after exposure for two months. The seeds are therefore planted either directly in the field or in nurseries as soon as possible after the harvest. The land is cleared and drained or bunded if necessary, and marked into square or rectangular plots and the seedlings are planted at a distance of about 10-30 ft., which depends on the fertility gradient of the soil. Cover crops to serve as shade, and to prevent erosion have also been used. In the first few years, inter-crops of coffee, cocoa, tobacco, sesame etc. are sometimes planted. Another practice is to plant 180-300 trees per acre, and after tapping for the first few years to thin these to half the number. *Hevea* seems to respond well to manures, especially to nitrogenous and phosphatic fertilizers, and to certain cases to lime. So far, no major insect, fungus or virus disease has been found that could not be combated successfully, but it is the constant fear of the *Hevea* plantations whether a disease may not some day appear in an epidemic form which might ruin the plantation industry. This was actually the case of the Dutch Guiana plantations which were finally given up on account of a virulent fungoid disease of the leaf.

When the girth of the tree is about 24" at a distance of about three ft. from the ground, which usually takes place about 5-7 years after planting, the tree is tapped either in the herringbone fashion or in V or U style by means of gourge or cutting knife, as for instance the *Michie Gollegde*. Care is taken to see that the incision reaches the inner cortex containing the laticiferous tissue, without damaging the cambium. The tapping as a rule is done in the mornings either according to half-spiral-alternate day system, or double-half-cut-in-3-days system, or on every week-day (Saturdays and Sundays excluded) in alternate months or fortnights, or giving the trees any other proper recouping periods. On the other hand, during periods of emergency great strain may be put on the tapping process, and slaughter tapping, increasing the breadth of the incision and the number of tappings may be practised. There is considerable variation in the yield of rubber from individual trees not only on account of their varying capacity of producing latex but of the rubber content of the latter which is found to change with the soil, and the topographical situation and the season as well as the age, and the hereditary make-up of the tree. Better yields are obtained by suitable selection of seeds ultimately aiming at the production of "Super" trees, and by vegetable propagation especially bud-grafting, aided by special care of the wounded parts. The world's acreage under *Hevea* cultivation is about 2,000,000 acres. In India the acreage is about 140,000 acres. The pre-war production of *Hevea* rubber was in the neighbourhood of 1,000,000 tons. Of this, India's quota was about 16,000 tons.

The *Hevea* latex is a milky white fluid having a dry rubber content of about 30 per cent. Of this 2·5-3 per cent is resinous matter. The rubber is marketed either as preserved latex or as solid rubber. The latter is available in two different grades, smoked sheet and crepe rubber. The preservative most commonly used for latex is ammonia. Apart from normal latex (with a dry rubber content of about 30 per cent) concentrated latices upto a D.R.C. of 80 per cent are available. Latex is slightly costlier than solid rubber because of the charges involved in the transport of large bulk of fluid.

Hevea rubber possesses very good processing properties as also a wide range of applications. Thus, in plasticity, adhesion and cohesion, vulcanizability, and general workability, it is found to excel all other types of rubber. Also in elasticity, tensile strength, corrosion and abrasion resistance, it compares favourably with other grades of natural and synthetic rubbers. In this connection it is interesting to note that in spite of the great advances made by synthetic rubber in recent years, *Hevea* rubber has still retained its supremacy in the fields of processing and utility.

Castilloa (*or Castilla*) *elastica* Cerv., has along with *Hevea*, established itself for the past several years as an important source of plantation rubber. Its history can be traced back to Jaun de Torquemada who described in his book "Monarquia Indiana" (Madrid, 1615) a substance called "Ulei" prepared

by Red Indians from a tree known as "Ulaquahnil" or "Ulequahnil" or "Ule" and which was used by them in medicine, and in water-proofing textiles. This tree has not attained much importance from the point of view of plantation industry, but the rubber obtained from it has successfully compared with other rubbers. Due to the extensive natural adaptation of the tree new tracts containing "Ule" have been found and exploited in central America, Brazil, Amazon region and the territory bordering on the north, as well as in the Andes.

Castilloa, which belongs to Artocarpoideae of the Moraceae family, attains the same size as *Hevea*, but its branching habit is characteristic. The branches bearing short-stalked, simple, distichous leaves measuring sometimes upto a foot in length grow almost horizontally with a slight droop towards the ends. The older branches fall off, and the newer ones develop obliquely upwards leading ultimately to the formation of a crown. The monoecious flowers are found on separate fleshy receptacles surrounded by imbricated bracts forming involucres. The receptacles do not, however, close completely as in many other plants belonging to the family. The male inflorescence has flower consisting of straight stamens, but having no perianth. The female inflorescence bears flowers having calyx and a unilocular ovary surrounded by a thin style divided into two staminiferous convoluted branches. The fruit is a drupe with a pulpy hull which dries up almost completely at maturity, and contains a small seed rich in oil which, as in the case of *Hevea*, does not appear to have been exploited.

For obtaining rubber the trees are completely felled and slaughtered. As a result of this many districts which abounded in *Castilloa* are now devoid of it ; but as mentioned above the adaptation of the tree to central American climate is so great that the species is in existence. In central America the trees are not felled, but tapped by means of horizontal or inclined cuts. The rubber obtained from this tree is inferior to that of *Hevea*. The climatic conditions suited for the growth of *Castilloa* trees are the same as those of the *Hevea* tree ; and as the *Hevea* trees yield a rubber of better quality, the cultivation of the former is found to be unprofitable. Further disadvantages of *Castilloa* are that the yield of rubber is low and the wounds made in the trees by tapping heal only with great difficulty.

Another important source of rubber is *Manihot Glaziovii* Mull., discovered by the French botanist Glaziovii near Rio de Janerio, and later described and named after him by Mueller in Martin's *Flora Braziliensis*. The tree is found widely distributed round Ceara (hence the name "Ceara rubber"), Rio Grande del Norte and Parahyba. Some seventy species of Manihot are said to be found in Brazil, though systematic chemical and botanical investigations on these are rather scant. It would appear that a species other than *M. Glaziovii* was cultivated in South America, and was well known in San Paulo and S. Brazil, but it was not botanically identified, nor was the quality of the rubber examined for a long time. Other Manihot rubbers are "Jequie" obtained from *M. dichotoma*, "Manicoba de Sao Francisco" from *M. heptaphylla*, and "Maniçoba de Pianhy" from *M. Pianhyensis*, but *M. Glaziovii* is generally considered to be the only one of economic importance.

The *Manihot* is an isolated representative of Adriancae (Crotonoideae) of the natural order Euphorbiaceae. *M. Glaziovii*, is a tall tree, having a girth of 1-3 ft., and starts branching even from a height of 3 ft. from the ground level. The leaves are simple petiolate, and have the characteristic of being "hand-shaped" with 3-7 "fingers". Male and female flowers are found on the same inflorescence which is a simple terminal spike or raceme. The male flower is smaller than female, decanderous with stamens usually erect and has a star-shaped nectary at the base. The trilocular ovary of the female flower carries three recurved fringed stigmas. The fruit is a capsule and splits on drying, its walls crumbling to pieces in the process. The seeds are small, dark and slightly flattened.

M. Glaziovii, although raced out by *Hevea*, possesses certain points of vantage which cannot be overlooked. It is a tree of granitic land, high and low, requiring much less moisture than *Hevea*, and as such it can be profitably used to extend to some extent the rubber-producing zone. Moreover, it does not deplete the soil as rapidly as does *Hevea* and it has the added advantage of yielding rubber even after 2 years' growth. Experience in Tanganyika seems to indicate that the tapping life of the tree can be prolonged over a number of years by the judicious use of the tapping technique. Altogether, if the same care of cultivation, selection, breeding and tapping are bestowed upon this tree as on the *Hevea* for improving the yield and quality of rubber, it does not seem unreasonable to believe that it will give profitable returns in certain parts of India (South) and in other places where labour is cheap and conditions are unfavourable to the growth of *Hevea*.

The tapping of *Manihot* is done much in the same usual way. In E. Africa a special method is employed. The bark is first coated with a coagulent for latex, and the upper portion is then tapped. The latex that flows out gets coagulated in the form of strips. The coagulated strips are then rolled into balls.

The quality of the rubber is inferior to that of para rubber. The resin content is rather high, and

the cost of production is also a bit high. The latex may be coagulated as in the case of *Hevea* by means of dilute acids and salts.

Ficus elastica, Roxb.; although this rubber is now classed under "Wild" rubber it was with this tree that the world's first rubber plantation was started in 1860 in Assam and in 1861 in Java. The tree and its rubber-yielding property were rediscovered accidentally by Roxburgh in Assam, and hence the names "Assam Rubber" or "India Rubber" have been assigned to it.

It is a stout handsome tree (Urticaceae, sub-order Artocarpeae) which usually commences growth epiphytically and often reaches an enormous size. It is found in the damp forests of the base of Sikkim Himalaya, Assam, Burma, Perak, and, according to Weight, now cultivated in most parts of South India. It is met with in Europe as a puny ornamental plant. In Germany it is grown as a home tree, under the name of "Gummi baum". In its native climate, however, buttress roots which spread out in all directions over long distances are found to develop. The trunk is massive, often several feet in circumference, and has a comparatively smooth bark. As with many other Ficuses, the branches give off adventitious roots which grow downwards and strike root on reaching the soil. The leaves are entire, oval or oblong, leathery and glossy. The species is characterised by its rosy coloured, enormous stipules that protect the bud and by unisexual flowers contained in a fleshy globular common receptacle open by a narrow mouth at the top. When the male and female flowers are not in separate receptacles, the former are at the mouth, and the latter occupy the rest of the cavity. The male florets are mono-adelphous and the female ones have oblong ovaries, each with its curved style and large stigma.

Although all parts of the plant contain latex which is said to yield about 30 per cent by weight of rubber it is not surprising to see that such a tree failed to be a successful plantation crop. The main reasons for htis failure are the comparatively small number of trees which could be planted per acre and the slow growth of the tree.

The trees are usually tapped by horizontal or slanting hatchet cuts generally about 10-20 cms. long. The yield of rubber is found to be high during the first tappings, but it dwindles rapidly as the tapping is continued. The slow vigour of the tree reflects also in the long periods of rest required. These factors hastened the overthrow of *Ficus* by the *Hevea* and the *Manihot* varieties. In India there were about 9,500 acres under *Ficus* plantation in 1934, but this area has considerably decreased during the last few years.

Ficus rubber contains more resins than the *Hevea* rubber, and is in no way equal to the latter in quality. The latex is not coagulated by acids, and is stable to mechanical treatment. The latex will coagulate spontaneously on exposure, the particles uniting to give a soft, resinous rubber.

Among other "Wild" rubbers are included those obtained from Kickxia (also called *Funtumia*), various species of *Euphorbia, Landolphia,* and *Clitandra, Mascarenhasia, Hancornia, Urceola,* etc.

Parthenium argentatum has of late assumed importance as a source of natural rubber in America. It is the Guayule (pronounced as "gwa-ee-oo'-lay" or "wee-oo'-lay") of the drier parts of northern Mexico and Southern States, and is said to be one of the few non-tropical sources of rubber. It belongs to the Compositae family which is generally regarded as occupying the highest position in the vegetable kingdom. Guayule is a lowly, woody, stubby shrub, seldom more than two feet and a half in height, growing wild on the limestone slopes covering an area of about 20,000 sq. miles in Northern Mexico, Southern Texas, Arizona, and New Mexico, where the annual rainfall is about 9-15 inches, and the summers are long, hot and dry. Its silvery leaves give it a desertic, dusty appearance. The plant does not possess any special system of laticiferous tubes, but rubber is secreted in the form of small granules in special cells in roots and stems. The root contains as high a percentage of rubber as the stem, and represents 45 per cent of the total rubber.

On account of the individualized and isolated latex cells, the guayule does not yield latex on tapping. The whole plant is pulled out, roots included, chopped up, and ground in water, and the floating rubber is skimmed off by mechanical means. The wild plant of which the yield averaged about 8 per cent of the dry weight remained for some time refractory to modern methods of cultivation and breeding. Experimental work on the cultivation of Guayule was carried out at Salinos and California some twenty years ago, and thanks to McCallum of the University of Arizona, the efforts at acclimatization and improvement of the plant by selection led to fruitful results. Among other things it was found that the soil for Guayule should contain a good percentage of the trace element: boron. The yield of rubber from the improved strains is 22 per cent of the dry weight, and the bearing age of the plant has been brought down from 10-20 years to 2-4 years. If the plant is not harvested after 2-4 years, its life-cycle may extend up to 40-50 years.

It is rather strange that although some 20,000 acres are devoted to guayule plantations in various parts of the U. S. A., Argentina and Chile no regular plantation industry seems to exist in Mexico. This is probably due to the abundant wild supply.

Factories for guayule rubber were started in Mexico about 40 years ago, the first one being at Torreon, with a capacity of a million pounds of wet rubber per month. When it was found that the wild supply was in danger of being exhausted in about 17 years, the Government introduced special legislation, and issued permits for harvesting only the mature plants in order to ensure a constant annual production of 10,000 short tons of guayule rubber.

Guayule rubber contains about 16-20 per cent resin, and when de-resinated compares favourably with the best *Hevea* rubber. As an emergency source of natural rubber the guayule rubber is said to be unrivalled. Also the cost of production has been reported to be very small, because the planting and harvesting operations are mainly carried out by machinery.

Gutta-percha and Balata.—These names are applied to the gums obtained from the latex cells of certain plants belonging to Sapotaceae family, particularly to the *Palaquium* species. Gutta-percha is obtained from the islands in the Malayan and Philippine Archipelagoes. This is also cultivated in Java. The natives of Malaya call it "Percha", and "Gutta" is the Malayan word for gum.

Gutta-percha was first introduced into Europe by Tradescant in the middle of the 17th Century. It was then known as "Plyable Mazer Wood". Nothing further was known about this plant till 1843 when it was re-introduced into Europe. In 1845, according to the suggestion of William Siemans, it was used for insulation of cables. Later on, it was used for water-proofing, and for making surgical goods. A large number of trees are commercially exploited for the production of gutta-percha. The particular species from which the original gutta-percha was obtained was the *Isonandra gutta.*

Balata is obtained from certain species of *Mimusops*, generally found in the Guianas, Venezuela, Trinidad, and surrounding regions. Balata is in many respects similar to gutta-percha.

The rubber is generally extracted from the mature leaves. The leaves are ground mechanically, the ground material is heated to about 70°C. for a suitable period in hot water with constant stirring, and the hot mass is then transferred into a large volume of cold water when the gutta that floats on the surface can be skimmed off. The yield is about 2-3 per cent, calculated on fresh leaves.

For obtaining balata the early practice was to fell the trees, and then collect the latex by making incisions at several points on the stem. But in certain places like British and Dutch Guianas, the trees are generally tapped, and the coagulation of the latex is brought about by allowing it to ferment for 2-3 days. Extraction methods for obtaining rubber have not so far been found successful.

Until recently the gutta-percha market was controlled by Chinese merchants, and they used the gum for the purpose of adulterating better qualities of rubber. But at present the genuine material is obtained from two plantations, one in Java, and the other in Malaya. Commercial guttapercha contains about 10-60 per cent of resins, mainly albane and flauvile present in the ratio of about 2 : 1. Balata also contains the same resins as gutta, but the ratio of albane to flauvile is 2 : 3.

Cryptostegia grandiflora, R. Br. (formerly known as *Nerium grandiflorum Roxb.*) and *C. madagascariensis* were known as rubber-yielding plants for the last hundred years or so, and a crude rubber was prepared from them and exported on a small scale under the name of Palay rubber from Africa and Madagascar which are supposed to be their real home. These are showy, flowering twiners which were introduced into various countries during the latter half of the last century. They are now commonly seen as ornamental creepers on hedges, verandahs, trellises and in gardens in the U. S. A., in Central America and in India. These plants are found even in a wild state in certain localities in this country where it has well adapted itself to the climate. The frantic search for rubber created by exigencies of war in recent years resulted in a re-discovery of these plants, and they are now regarded as the quickest growing plant producing high-grade rubber.

The *Cryptostegia* or *Crypto-vine* belongs to Asclepiadaceae but in vegetative habit is like Apocynaceae with which it was formerly confused. It has simple, opposite, deep green, glossy, coriaceous deciduous leaves. Its large pale pinkish purple flowers are either solitary or in di- or tri-chasial cymes. The essential organs are complex. The stamens and style are usually united to form a gymnostegium, the anthers and the stigma being concrescent. Pollination takes place by the translator mechanism. The fruit is a pair of conical, triangular follicles, and the seeds are numerous and crowned with tufts of silky hair for wind dispersal.

Vigorous attempts are being made at large-scale cultivation of the vine in suitable localities in this country as well as in Florida, the Bahama Islands and especially in Haiti where some 65,000- 75,000 acres were already planted to the crop up to last year and the plantings were expected to reach a total of 100,000 acres in the course of 1944. The carefully selected and treated seeds are germinated in nurseries and then transplanted in the open at the rate of about 4,000 plants per acre. The vines are grown in hedge-like rows and after a year's growth when a sturdy root-system is developed latex can be collected in

bamboo tubes or troughs from the shoots of which the tips have been clipped off so as to let the latex drip in. Latex may also be collected by tapping older trunks which may attain a diameter of 5-6 inches. Tapping done every two days does not seem to affect the vitality of the plant. Rubber is obtained also from the clogged ends of clipped shoots. Latex is present in leaves and stems and severe pruning will yield both these without injury to the adult plant. Claims have been made that mature plants may yield about 250 lb. of rubber per acre and that one man per acre can easily harvest the crop.

The latex obtained from the most promising of the plants of *C. grandiflora* contains about 11·8 to 21 per cent of dry rubber depending upon locality. Unlike *Hevea* latex, the *Cryptostegia* latex when treated with acetic or other acids in any dilution fails to produce a good coagulum and a clear serum. The acidity of *Cryptostegia* latex is also higher than that of the *Hevea* latex. As the result of elaborate experiments conducted on the coagulation of the latex obtained from *C. grandiflora*, it has been found that addition of sufficient quantity of water to the latex causes coagulation, about 10 to 12 volumes of water being required for this purpose. In quality *Cryptostegia* rubber compares very favourably with the *Hevea* rubber. In fact it has been reported that *Cryptostegia* rubber can be used even for high grade mechanical rubber if all the processes from coagulation to smoking are carefully controlled.

The U.S.S.R. have recently become much interested in rubber-yielding plants and organized some thirty botanical expeditions to ransack her vast territories and find native sources of this important raw material most of which she used to import till recently. In these expeditions flora of the Pacific shores at Vladivostok and Sakhalin, south-west to the Crimea and north to the Arctic Circle was studied covering some 100,000 species. About 5,000 plants were carefully analysed and tested, of which many were found to contain small quantities of rubber. In one expedition led by Rodin, unidentified species of Taraxacum was found in the valleys of the Tian-Shan mountains in the Republic of Kazakstan in Russian Central Asia, of which the roots contained rubber. This was the famous *Taraxacum kok-saghyz*, (*Kok* meaning root and *saghyz* "to chew"), so named because of its being used as a sort of chewing gum by the Kirghiz and Kazak tribes in Turkestan. Other Compositae of interest were *Scorzonera tau-saghyz* and the *krym-saghyz, Taraxacum hybernum*, Ster.

Like other Dandelions, the kok-saghyz is a low shrubby plant with a thick perennial primary root crowned by a very short sympodial stem. The root-system keeps on growing in the frozen ground long after the leaves and stem have been killed by the frost. The rubber is contained in the laticiferous tissue of the plant, especially of the roots which even when they are dry show elastic threads on breaking. The floral mechanism is of the usual type of the family and shows the final autogamy clearly.

In 1942 Russia is reported to have planted some 2,000,000 acres of its dry land with this rubber plant. The seed is very small and requires pre-treatment for a high percentage of uniform germination. The crop is harvested by digging the roots in 6-12 months. One year old roots yield up to 7·50 per cent of dry rubber and this percentage is being raised by systematic selection and breeding, and the use of fertilizers. The plant is being tried also on the experimental farms in the U. S. A., Canada, Alaska, Chile and Argentina and more than 18,000 lb. of the roots have been harvested from the first experimental plantings in the U. S. A. In Montana the yield was estimated at 4500-5000 lb. of roots or 45-55 lb. of rubber per acre. The yields obtained in America seem to be higher than the average ones obtained in the dry regions of the U. S. S. R., but the areas where the kok-saghyz thrives seem to fall within the sugar-beet zone. In Canada the yields obtained varied enormously, from 1600 to 8100 pounds of roots per acre.

Thus we see how the early rubber plants helped to develop the plantation industry in the tropical regions and how the co-operative efforts of botanists and chemists are revealing unsuspected sources of this strategic raw material. A number of plants in different countries were found to produce rubber-containing latex, but owing to want of application of the modern technique of the improvement of plants, have fallen in the background. The American and Russian examples have shaken the old belief that plants of the temperate belt were incapable of producing rubber and that rubber plantations could be established only in the tropics. They have pushed the rubber-growing zone northwards to such a point that countries habitually dependant on foreign supply may well pick up an incentive to seek self-sufficiency in rubber. It is clear enough that the era of exploration should continue in the post-war world, the age of hopes and promises ; and then, botanists, plant-breeders, plant physiologists—scientists whose worth to a nation is so often unappreciated until a major crisis occurs will be none too many for the task.

APPENDIX I

	Name	Natural Order	Trade Name	Habitat
1.	*Achras Sapota* L.	Sapotaceae	Chicle gum	Central America
2.	*Alstonia Dürkheimiana*	Apocynaceae	—	New Caledonia
3.	Amarjot			
4.	*Argemone mexicana*	Papaveraceae	—	Tropical America
5.	*Bleekrodia tonkinensis*	Moraceae		French Indo-China
6.	*Calotropis procera*	Asclepiadaceae		—
7.	*C. acia*			—
8.	*Carica papaya* L.	Caricaceae	—	—
9.	*Carpodinus landolphioides*	Apocynaceae		Cameroons
10.	*C. uniflora*			,,
11.	*Castilloa costaricana*	Moraceae		Costa Rica
12.	*C. elastica* Cerv.	,,	Panama rubber	Central America
13.	*C. lactiflua*	,,	—	Mexico
14.	*C. micoyensis*	,,	—	Costa Rica
15.	*C. panamensis*	,,	—	Panama
16.	*C. Ulei*	,,	Caucho	Amazon
17.	*Chrysothamnus*	Compositae	Crysil rubber	Western U. S. A.
18.	*Clitandra elastica*	Apocynaceae	—	Ivory Coast
19.	*C. laurifolia*	,,	—	,,
20.	*C. nzoude*	,,	Black Congo	Tropical Africa
21.	*C. orientalis*	,,	,, ,,	,, ,,
22.	*C. Simoni*	,,		Cameroons
23.	*Cnidoscolus*	Euphorbiaceae	Chilte rubber	North & Central Am.
24.	*Cryptostegia grandiflora* R. Br.	Asclepiadaceae		Tropical Africa.
25.	*C. madagascarensis*	,,	Lombiro	Madagascar
26.	*Daemia* R. Br.	,,		
27.	*Dyera* spp.	Apocynaceae	Jelutong or Dead Borneo or Pontianak	Borneo
28.	*D. Costulata*	,,	—	,,
29.	*D. Lowii*	,,	—	,,
30.	*Ecdysanthera cambodiensis*	,,	—	French Indo-China
31.	*E. Godefroyana*	,,	—	,,
32.	*E. lineariearpa*	,,	—	,,
33.	*E. micrantha*	,,		Burma
34.	*E. Quintareti*	,,	—	French Indo-China
35.	*E. Tournieri*	,,	—	,,
36.	*Euphorbia antiquorum*	Euphorbiaceae	—	—
37.	*E. dracunculoides*	,,		—
38.	*E. fulva*	,,	Palao amarillo	Mexico
39.	*E. geniculata*	,,	—	—
40.	*E. grandidens*	,,	—	S. Africa
41.	*E. hirta*	,,	—	—
42.	*E. intisy*	,,	Intisy or Herotra	
43.	*E. ligularia*	,,	—	
44.	*E. neriifolia* L.	,,	—	Madagascar
45.	*E. nivulia*	,,	—	Madagascar
46.	*E. pirahazo*	,,	—	Madagascar
47.	*E. pulcherrima*	,,	—	—
48.	*E. rhipsaloides*	,,	Alnecidino or Potato rubber	Angola
49.	*E. Royleana*	,,	—	—
50.	*E. tetragona*	,,	—	S. Africa
51.	*E. Tirucalli* L.	,,	—	Natal
52.	*E. triangularis*	,,	—	S. Africa
53.	*Ficus babu*	Moraceae	—	Belgian Congo
54.	*F. elastica* Roxb.	,,	Karet or Rambourg	Assam
55.	*F. hispida*	,,	—	—
56.	*F. hypophaea*	,,		Dutch N. Guiana
57.	*F. infectoria*	,,	—	—
58.	*F. nekbedu*	,,	—	Belgian Congo
59.	*F. palmata*	,,	—	—
60.	*F. Pr eusti*	,,	-	Camaroons
61.	*F. rigo*	,,	-	British Guiana
62.	*F. Schlechteri*	,,	—	New Caledonia
63.	*F. Supfina*	,,	—	Dutch N. Guiana
64.	*F. Vogelii*	,,	—	W. Africa
65.	*Forsteronia floribunda*	Apocynaceae	—	Tropical America
66.	*Funtumia elastica* Stapf., or *Kickxia elastica* Blume p.p	,,	Silk Rubber or Lagos or Iré rubber	Africa
67.	*Gonogrypta Grevei*		Kompitro	Madagascar

APPENDIX I—(*Contd.*)

	Name	Natural Order	Trade Name	Habitat
68.	*Heplopappus* spp.	Euphorbiaceae	—	West U. S. A.
69.	*Hevea Benthamiana*	,,	—	N. Amazon
70.	*H. brasiliensis*	,,	Para Rubber	Amazon
71.	*H. guyanensis*	Apocynaceae		,,
72.	*Holarrhena microleranthera*	,,	Piri piri	German E. Africa
73.	*H. antidysenterica*		—	—
74.	*Hancornia speciosa* Gomez		Santos or Rio Sheets or Magnalbeira Rubber	S. and C. America
75.	*Ichnocarpus frutescens*	,,	—	
76.	*I. xanthogolax*	,,	—	
77.	*Jatropha curcus*	Euphorbiaceae	—	Dutch New Guiana
78.	*J. gossypifolia*	,,	—	—
79.	*Kickxia elastica*	(See *Funtumia elastica*) Apocynaceae	—	—
80.	*Landolphia bracteata* A. Dew	,,	—	West Africa
81.	*L. camorensis* Benth. et Hook	,,	African rubber	,,
82.	*L. capensis* Oliv.	,,		,,
83.	*L. crassipes*	,,	Fingotra	Madagascar
84.	*L. Dawei*	,,	—	East Africa
85.	*L. Droogmansiana*	,,	—	
86.	*L. fingimena*	,,	—	Belgian Congo
87.	*L. florida* Benth.	,,	—	Madagascar
88.	*L. Gentilii*	,,	Red Kassai	West Africa
89.	*L. Hendelotti*	,,	—	Belgian Congo
90.	*L. hispidula*	,,	—	West Africa
91.	*L. kilimandjarica*	,,	—	Madagascar
92.	*L. Kirkii*	,,	—	East Africa
93.	*L. Klainei*	,,	—	East Africa
94.	*L. Lecomtei* A. Dew	,,	—	Belgian Congo
95.	*L. lucida* K. Schum.	,,	—	West Africa
96.	*L. madagascariensis*	,,	—	,,
97.	*L. Manii* Dyer	,,	—	,,
98.	*L. Michelinii* Benth.	,,	—	,,
99.	*L. owariensis*	,,	—	,,
100.	*L. parvifolia*	,,	Muteke	Rhodesia
101.	*L. Perrieri*	,,	Piralahy or *Majunga noir*	Madagascar
102.	*L. Petersiana*	,,	—	East Africa
103.	*L. senegalensis* D.C.	,,		West Africa
104.	*L. sphaerocarpa*	,,	Reialbo	Madagascar
105.	*L. Stolzii*	,,	—	East Africa
106.	*L. subturbinata* Stapf.	,,	—	West Africa
107.	*L. Thollonii*	,,	—	Africa
108.	*L. tomentosa* A. Dew	,,	—	West Africa
109.	*L. Traunii* Sadeb	Euphorbiaceae	—	,,
110.	*Landolphia ugadensis*	,,	—	Uganda
111.	*L. Watsoniana*	,,	—	East Africa
112.	*Lenconolis*	,,	—	Indo-Malay
113.	*Loranthaceae* (spp. ?)	Apocynaceae	Thina rubber	Bahia
114.	*Manihot dichotoma*		Jacquie	Ceara, Rio del Norte &
115.	*M. Glaziovii* Müll.-Arg.		Ceara	Parahyba
116.	*M. heptaphylla*	,,	Maniçoba de	Bahia
117.	*M. piauhyensis*	,,	San Francisco	,,
118.	*Mascarenhasia arborens*	,,	Maniçoba de	Madagascar
119.	*M. elastica* K. Sch.	,,	Guidroa	East Africa
120.	*M. laceolata*	,,	Mgoa rubber	Madagascar
121.	*M. lisianthiaflora*	,,	—	,,
122.	*M. mangorensis*	,,	—	,,
123.	*Micrechites Bailloni*	,,	—	Indo-China
124.	*M. napeensis*	Cactaceae	—	,,
125.	*Nerium odorum*	Apocynaceae	—	,,
126.	*Oncinotis hirta*	,,	—	Belgian Congo
127.	*Opuntia*	Compositae	—	America
128.	*Parameria barbata*	Euphorbiaceae	Rubber-like sub.	Burma
129.	*P. philippinensis*	Asclepiadaceae	—	Philippines
130.	*Parthenium argentatum*	Apocynaceae	—	Mexico
131.	*Pedilanthus tithymaloides*	Asclepiadaceae	—	—
132.	*Periploca canariensis*	Apocynaceae	—	Belgian Congo
133.	*Pirabarium diudo*		—	French Indo-China
134.	*Plumeria alba*	Euphorbiaceae	—	—
135.	*Raphionacme utilis*	,,	—	Angola

APPENDIX I—(*Continued*)

	Name	Natural Order	Trade Name	Habitat
136.	*Rhynchodia Wallichii*	Euphorbiaceae	Ekanda rubber	Burma
137.	*Sapium* spp.	,,	—	S. America
138.	*S. biglandulosum*	,,	Caucho blanco	Colombia
139.	*S. insigne*	,,	—	Indo-Malay
140.	*S. Jenmani*	,,	—	Br. Guiana
141.	*S. tapuru*	,,	—	Amazon
142.	*S. Thompsoni*	Compositae	—	Colombia
143.	*S. vernum*	,,	Colombian or Virgen rubber	Amazon
144.	*Scorzonera krim-saghyz*	Asclepiadaceae	—	U. S. S. R.
145.	*S. tau-saghyz*	Leguminosae	—	,,
146.	*Secamonopsis madagascariensis*	—	—	Madagascar
147.	*Soja* Max.		Vahimainty	—
148.	*Synedenium grantii*		Norepol-rubber-like substances	—
149.	*Tabernaemontana coronica*	Apocynaceae		
150.	*Thevetia neriifolia*	,,		
151.	*Urceola actuoacuminata*	,,	Separat	Indo-Malay
152.	*U. brachysepala*	,,		
153.	*U. elastica*	,,		
154.	*U. esculenta*	,,	—	Rangoon
155.	*U. malaccensis*	,,	—	Malacca
156.	*U. Mangay i*	,,	—	Indo-Malay
157.	*U. pilosa*	,,	—	Borneo
158.	*Vallaris Heynei*	,,	—	Indo-Malay
159.	*Willughbeia firma* Bl.	,,	—	—
160.	*Wrightia tinctoria*	,,	—	Java, Sunda
161.	*Xylinabaria Reynodi*	,,	—	Indo-China
162.	*Zea Mays L.*	Gramineae	Rubber-like substances	U. S. A.

MEDICINE AND PUBLIC HEALTH

FOOD CONSUMPTION LEVELS IN THE UNITED STATES, CANADA AND THE UNITED KINGDOM

This report issued by the United States War Food Administration was prepared by a special Joint Committee set up by the Combined (Anglo-American) Food Board in May, 1943, as a guide for the Board and other governmental agencies in the allocation of foods in short supply. The Board instructed the Committee to consider and compare the pre-war, present, and prospective food consumption levels of the United States and United Kingdom. Canada was also invited to participate in the inquiry and subsequently accepted.

The work of the Committee fell under two main heads: Supplies and Distribution, which involved the collection of such material as the total disappearance figures for food in each country, ration allowances, extent of employment and intensity of labour, distribution among consumer groups in different areas and different income groups, waste and losses occurring in the process of distribution, etc.; and Nutrition and Health, which dealt with the comparative analyses of nutritional needs of populations, determination of the nutritive content of the per capita food supplies available in the different countries, and an evalution of the effects of dietary changes that have taken place or which might be required.

This report gives information on food supplies for civilian consumption in the three countries in 1943 and in the pre-war period for each (1934 to 1938 for the United Kingdom, 1935 to 1939 for the United States and Canada). Part I deals with the general problems involved in such a study and the methods adopted, the actual comparisons of consumption levels being presented in Part II in three sections: Comparison of Nutrient Supplies and their Relation to Requirements; Commodity Supplies in Relation to General Dietary Needs (by food groups and by individual commodities); and, finally, Trends of Supplies (1940-'43 and forecasts for the period July, 1943 to

June, 1944). Supporting data are presented in a number of charts, tables and appendices.

TUBERCULOSIS IN THE ANIMAL WORLD

Sydney Gordon Tippett, (*The Veterinary Journal*, June, 1944) basing his thesis on wide experience and investigation as medical superintendent of an important sanatorium in Great Britain, recommends that steps be taken to get animal tuberculosis under control, it being clear that human tuberculosis can never be controlled unless the disease is first controlled in the animals with which man comes in contact, and upon which he depends for a part of his food. The disease must be attacked among cattle swine, and fowl. Both veterinary surgeons and doctors have contrary ideas as to dangers of the bovine tuberclo bacillus, notwithstanding that the infection among children runs high as a consequence thereof. While bone and joint tuberculosis is more frequently of human origin, yet it is apparently not realized that the drinking of raw cow's milk frequently sets up fatal and crippling forms of the disease in children. Nineteen percent of urino-genital and 16·6 per cent of tuberculosis meningitis have been found to be of bovine origin, and the largest percentage of cervical and abdominal tuberculosis in children under five years of age is traceable to cow's milk. One cannot expect the general public to understand the dangers of tuberculous milk until the medical profession itself becomes unanimous on the question of eliminating the tubercle bacillus from the milk supply. There is no ground for the belief that ingesting small numbers of tuberclo bacilli has significant or lasting immunizing effect. The only method of making raw milk safe is by complete eradication of bovine tuberculosis, as was done in the Channel Islands and the United States through the systematic resort of the tuberculin test. Quoting: "For a real effort to control tuberculosis in human beings, the medical profession can thus learn from the veterinary work in the place of waiting until the X-ray shows distinctive disease of the lungs. . . ."

PROCESSED SOYA BEAN IN BALANCING INDIAN DIETS

D. K. CHATTERJEE,
CALCUTTA

BEFORE actually proceeding with the scientific considerations of the nutritional value of soya bean, it will not be out of place to outlay the history of our food requirements and their subsequent developments. This may help us to appreciate the importance of balancing our ordinary diets.

Food has always played a very prominent part in the mental and physical progress of mankind. In the Dark Ages, when mystries of growth, development and sustainance were not scientifically revealed to the cave man, his choice of foodstuff was mainly guided by animal instincts. That is why in course of the struggle for survival during his wild existence, the primitive man's food requirement was similar to that of wild animals. When this instinct was superseded by discrimination for taste, the choice became varied. This variation in the old and uniform food habit was perhaps mainly responsible for the growth of different inclinations and faculties in our ancients and thus the effects of food on the formation of body and mind came to be known. All these led the more scientific minds to formulate theories on food value and confirm them in practice.

The entire process of dietic evolution and the corresponding human progress may be summed up as follows:

Tired of their monotonous diets of raw flesh and scorched meat, the huntsmen of Stone Age were moved by instinct to taste the vegetable and other diets of changed nutritional constituents (which might have acted on the series of slumbering cells of the brain). This change in dietary seems to be, to a considerable extent, responsible for driving them from progress to progress, promoting in them the urge for construction and preservation, as well as developing in them an anesthetic sense—the key rules of an organized social life.

To-day, scientific inquisitiveness has ably established that from an epoch of high protein diet in carnivorous age, the world has drifted to this period of scientifically calculated feeding, which demands of us that our food requirements should be balanced in accordance with the demands of body and mind.

Recent advances in chemical and biological science make analysis and synthesis of our requirements possible. Accordingly, nutritional requirements in terms of chemical constituents have been formulated by science, but social habits, taste craze and environmental factors influence national diet menu.

Thus with reference to the consumption of protein, the German schools advocate a liberal protein allowance. But Chittenden and Hindenhede in Denmark cried for limitation. Fischer, Cassel, Osborn, Mendel, Hopkins emphasize the quality.

To settle this difference in opinion, various scientific centres undertook study of high concentration of protein on organism. The data obtained favour the view that high protein level does not exert any unfavourable influence on the kidney.

In case of fat, there also exists a great difference in opinion. According to many 45 to 60 grams of fat is quite sufficient, whereas others favour 50 per cent more.

Thus the difference of opinion is always there as to the quantitative and qualitative nature of the dietary constituents, but there is no difference of opinion as to the low nutritive value of an entirely carbohydrate food, made more injurious by the presence of cellulose and fibres, which are assimilated only with the greatest difficulty.

It is in this that we face nutritional disaster, as the average daily diet in India consists mainly of carbohydrates in one form or other. This practice is responsible not only for a low level of our physical efficiency but has also at the same time disturbed the rythmic equilibrium of organic secretions which play such an important part in the harmonious building up of proportionate bodies and balanced minds. Only a regular supply of balanced diet preserves the secretive equilibrium and helps the normal growth.

Unbalanced dieting, either due to inefficient knowledge of nutrition or due to perpetual economic difficulty, leads to the disturbance of the rythmic phase of organic function with the result that pathological conditions set in.

The following is a comparative study of the constituents of the ill and well balanced diets published in the Health Bulletin No. 23 of the Government of India :—

	I *Ill Balanced Diet*	II *Well Balanced Diet.*
Protein	38 gm	73 gms.
Fat	19 ,,	74 ,,
Carbohydrate	365 ,,	408 ,,
Calories	1750	2590
Calcium	0·16 ,,	1·02 ,,
Phosphorus	0·60 ,,	1·47 ,,
Iron	9·00 mgms.	44 mgms.
Vitamins		
A (I. U.)	500	7000
B_1 (I. U.)	160	400
C ,,	15 mgms.	170 mgms.

The Bulletin finds, the standard of diet under Group I to be of a very low nutritional value. We have ourselves constantly seen that the poor in India lives on a diet, whose Protein, Fat and Vitamin constituents are even less than half of what has been tabulated in Group I. While it is not difficult to understand what the condition should be of a community sustained by such a poor diet, the plight of the average Indian is beyond all description. It may be suggested that much of the physical and mental backwardness of a section of the Indian people is due to a poor food selection. While introducing soya bean as an ideal balanced diet for Indians, we shall try to deal with the traditional as well as the scientific nature of the nutritional constituents in soya bean.

The traditional inclination of the Indian people is directed towards vegetarian diets. But recent scientific observations of experts show that an entirely vegetable diet can hardly meet the requirements of our body and mind. The great sages prescribed vegetarianism for people of India. This is of course against the present scientific trend. As a solution to these contradictory theories of past and present sages, we feel inclined to introduce soya bean as the missing link. It is of vegetable origin but possessing most of the favourable properties of an animal diet.

While dealing with the scientific nature and the subsequent laboratory treatments to render soya bean more suitable as a nutritive factor, we shall include experimental data, both chemical and biological, in confirmation of our line of work.

The food value of soya beans centres principally round its contents of high percentage of quality protein and unsaturated fat, besides vitamins and minerals in a high degree. These have secured for soya bean a very exalted position in the list of natural foodstuffs scientifically recommended for human use.

Publications which are already extensive often mention the role of soya bean in making *blitz krieg* possible for Germany and Japan. More than once it has been mentioned that Chinese labourers are hardier than their colleagues in any part of the world though their cost of living is much lower than that of their friends elsewhere.

On the other hand, there have been several publications, both scientific and popular, regarding the difficulty in digestion of the protein of soya bean, and this takes away much of its value.

This led us to serious thinking, and a series of experiments on the digestibility of soya bean protein were conducted. In course of these experiments we found out some structural peculiarities in the linkage of the amino-acids of the soya protein. This unusual linkage system might be considered as the main agent of difficulty in digestion. Once these linkage systems are eliminated, the digestion immensely improves.

Before coming to the more complicated portion of soya bean protein structure and its influence of digestibility, we shall state our analytical results.

Analysis was done on soya beans collected from different sources and varieties. This need not be dealt with separately in this paper. On analysis it was found that the quantity of protein, fat and carbohydrate varied according to the variety of seeds, but

not much difference was observed in seeds of the same variety collected from different sources.

From our analysis, we came to the conclusion that "mammoth yellow large" seeded variety of seeds grown in Assam and Tista Valley, Darjeeling, were found most suited for nutritional purposes.

Here, as we are dealing with soya bean in its dietary value, we have entirely confined ourselves during experimentation to the mammoth yellow large seeded variety. The following are the findings of our laboratory investigations :—

Soya bean protein : 38 40 per cent. The total protein content ranges from 38–40 per cent. The bulk of this protein consists of globulins. One fraction constitutes more than 90 per cent of the total globulin, separated out of a 10 per cent sodium chloride solution by ammonium sulphate at 55 per cent saturation. The rest of the globulins did not separate out till the saturation of the ammonium sulphate was pushed to 66 per cent. The first portion of the total globulin responded to the physical and chemical tests of glycinin, which has often been mentioned as the principal protein of soya bean. The portion that separated out at 66 per cent saturation of ammonium sulphate, did not provide us with any definite nomenclature though most of its characteristics were similar to those of phaseolin.

The mammoth yellow large seeded varieties always contained traces of albumin. In one particular variety obtained from Darjeeling, we found about 3·75 per cent albumin present. But this particular variety being no more available to us, we had no opportunity to confirm this result. In course of our general analysis, we observed that the percentage of albumin in deep colour varieties is higher than in paler varieties. Along with these, proteose which is soluble in water could also be detected. It is assumed that soya protein, specially glycinin, is present in the seed in the form of glycinate of alkaline earths, as well as with alkaline earth phosphates.

The soya protein is completely dissolved in alkali, this base combining capacity of soya bean protein is perhaps due to the excess of dicarboxylic amino-acids not help in amide linkage.

On analysis the following amino-acids and their quantity were obtained :—

(1) Glycine—1·1%, (2) Alanine—0·30%, (3) Valine—0·53%, (4) Leucine—7%, (5) Proline—4%, (6) Phenylamine—5%, (7) Asparatic Acid—3%, (8) Glutamic Acid -18%, (9) Serine—1·25%, (10) Tyrosine—2%, (11) Arginine—5%, (12) Histidine—1·25%, (13) Lysine—3%, (14) Tryptophane—1·72%, (15) Cystine—2·25%, (16) Ammonia—2%, (17) Methionine (possibly) Traces.

In course of isolating these amino-acids, we had to adopt different processes of hydrolysis. Tryptophane was our greatest trouble, as it broke up completely during acid hydrolysis. Hydrolysis with a varied strength of acids and alkalies gave us the above results. We observed that most of the amino-acids of soya protein had a tendency to permeate into one another and was liable to produce inconsistent results. The above results were confirmed by more than one tests.

Results of analysis already published in other places are not in entire agreement with our results, but we have worked with the Indian seeds and this may account for the differences.

Denaturation and coagulation.—Unlike animal proteins, the soya protein coagulates and denatures at a temperature above 100° and in presence of moisture. Prolonged boiling in water results in dehydration of the protein. The denatured protein contains less total nitrogen and more hydrogen and oxygen than the original protein. The iso-electric range also becomes less wide. Denatured soya protein has higher viscosity.

The nature of digestive activity also changes in denatured protein. During denaturation, a structural alteration takes place which leads to a rearrangement of the linkage of the sulphur atoms of the molecules. Raw soya bean protein gives no colour with sodium nitropruside in presence of ammonia. But denatured protein gives a strong magenta pink colour, showing that the sulphydryl groups have been released during the change. This change in colour served us as an indication in detecting the denaturation of the soya bean protein.

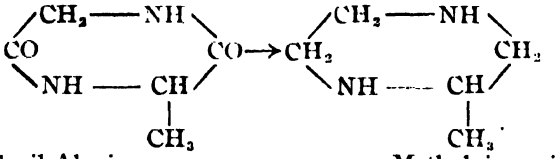
Digestibility.—As the question of the digestibility of soya protein forms the nucleus of our discussion, we shall try to deal with it somewhat in detail.

In course of our experiments on analysis by enzymic hydrolysis, we were struck by the consistency with which almost an equal amount of residue appeared every time, and we observed that this residue was not being acted upon by any of the proteolytic enzymes even under favourable conditions.

We altered conditions of hydrolysis by changing concentrations of acid and alkali, by changing concentration of the enzymes, by changing the nature of enzymes and also by changing the sources of origin of the enzymes. We observed that these altered conditions brought about a change in the velocity of hydrolysis as well as in the rate of liberation of amino-acids but the proportion of unattacked residue remained the same. Further we observed that (*a*) this particular portion of soya bean protein which could not be acted upon by enzymes remained optically stable, while the rest of the protein underwent racemitation under alkaline conditions, (*b*) this portion of soya bean protein again exhibited a very strong affinity to an azonium base of the type of safranine, and (*c*) from this portion as well, a few piparazines were isolated by reduction.

This led us to postulate a theory on the complex nature of amino-acid linkage of soya bean protein.

Marston accepts the safranine reaction as indicative of the presence of diketopiperazine rings. Further on reduction of the two carboxyl groups of diketopiperazine ring with sodium and alcohol, a few piperazines were obtained. We believe that methylpiperazine isolated was produced by the reduction of glycyl-alanine anhydrides, originally present in the hydrolysate.



Glycil-Alanine Methylpiperazine

Positive colour reactions for diketopiperazines were also obtained with picric acid, alkali and *m*-dinitrobenzene.

Oxamides were readily isolated after oxidation of the protein hydrolysate, and this was obtained in excess of the amount, that could be accounted for by the quantity of glycine present (the only peptide that yields oxamide under conditions employed in glycyl-glycine).

All these reactions and indications convinced us of the presence of diketopiperazine rings in the unacted portions of soya bean protein. We suspected formation of diketopiperazine rings in the protein hydrolysate by secondary condensations from the previously liberated amino-acids. Accordingly, further experiments were continued by avoiding all the favourable conditions of *p*H and temperature which helped Emil Fischer and Abderhaldane to synthesize diketopiperazine rings. We even went further, and in some of our experiments, we did not allow the hydrolysis to advance sufficiently in order not to encourage the usual liberation of amino-acids (of course the control was not very rigorous) so that the chance of any secondary condensation was minimized ; but even then the colour reaction of diketopiperazine rings was positive as before.

This experiment certainly favoured our assumption that diketopiperazine rings were present in the protein of soya bean and that they were not the outcome of a secondary reaction.

By applying Forbe's method, we achieved a separation of the proteins according to their linkage and structure. The entire lot of purified protein was combined with dye stuff safranine but the dye stuff remained in stable condition with only about one third of the total quantity of protein. Separation of coloured and uncoloured portions of the protein was done as far as practicable and afterwards the coloration was removed with butyl alcohol. Chemical tests of these two protein portions gave the following results:

1. When attacked with nitrous acids, the portion that did not combine with dye stuff evolved nitrogen, while no nitrogen evolved in dye-stuff-combined portion of the soya bean protein.

2. The portion of protein that was purified from the dye-stuff combination remained optically stable, while the portion that did not combine with the dye-stuff racemized.

3. Most of the colour reactions for diketopiperazine rings were positive with the fractions that combined with the dye-stuff but not so in the case of uncombined portion.

From the results obtained we propose to say that though the principal linkage of amino-acids in the total soya bean protein is of polypeptide character (as per definition of Hofmeister and Fischer), there exists as well another important type of linkage corresponding to Abarhelden's diketopiperazine ring type. We also presume from the data obtained that these diketopiperazine rings were originally present in the seeds and not formed from secondary condensation during hydrolysis.

The presence of diketopiperazine rings in the protein of soya beans clearly explains the cause of the difficulties in its digestion so often communicated through publications.

Attempts were made to hydrolyze these diketopiperazine rings by different proteolytic enzymes but results have been almost negative. A very slow hydrolysis was observed in the case of activated trypsin and this we think falls under the classification of Matsui and Ishayama, who claim that diketopiperazines with free carboxyl groups were very slowly split up by activated trypsin. The hydrolysis was so slow that the progress was almost imperceptible. We neglected the issue in our final conclusion.

A second factor which is more mechanical than chemical in character was also found to interfere in a considerable manner with the digestibility of soya bean protein.

We have found that most of the vegetable proteins are mechanically enveloped in strong coatings of cellulose. In course of protein digestions, the cellulose is not very quickly acted upon by enzymes and this leads to the passage of a certain percentage of cellulose-covered protein in roughage.

From subsequent experiments that we carried on in the line, we had reason to disagree with authorities like Lucias Nichols, who declared that vegetable proteins in general were inferior to animal proteins in biological value. In some cases the vegetable proteins are undoubtedly of lower nutritional order because of the absence of a few essential amino-acids but in most of the vegetable proteins, under our

observations, we found the presence of sufficient quantities of essential amino-acids and when these proteins were purified and freed from cellulose embeddings, we found no cause of any complaint about its efficiency in promoting growth or in building tissue. This leads us to conclude that the defect is not in the protein itself but in its strong cellulose cover which protects it against the action of digestive enzymes.

In the case of raw soya bean protein, the same conclusion may be drawn. During analysis, we detected the presence of six essential amino-acids, but publications have appeared about the low biological value of soya bean proteins. Our biological feeding experiments have brought before us that an important fraction of soya protein passes out without being acted upon in the digestive tract.

A series of feeding tests were done on rats with raw soya bean powder. In some cases, the raw soya bean powder was coloured with indigestible fast colour, and we found the soya bean powder containing indigestible soya protein (with both peptide and diketopiperazine linkage) at the end of the digestive canal.

Further, the analysis of excretion of rats living on raw soya protein indicated qualitative and structural similarity to the intake protein.

All these show that the indigestible nature of soya protein is due principally to two factors, namely, (1) presence of diketopiperazine rings of linkage, and (2) presence of a strong cellulose envelope which does not allow the embedded protein to be acted upon by the digestive fluid.

(To be concluded)

BOOK REVIEWS

China and Britain —By Sir John Pratt. Published by Collins. Pp. 128, with 12 plates in colour and 68 illustrations in black and white. Price 8*s.* 6*d.*

This is an admirable monograph written with sympathy and understanding. People seldom realize how great is China's contribution to civilization as we know it ; and Sir John's book is a timely reminder that we should respect China not only for her signal services towards the exorcism of the fascist ghost, but also for what she has done in furthering the cause of civilization in the light of her own singular spiritual endowments. Where all the chapters are equally interesting, one is yet constrained to single out the chapters on China's gift to the West, Ancient China, China's Civilization, Philosophy, Religion and Art for special notice. Sir John's analysis of the spirit that underlay China's social organization brings out the ethical bias that was as much characteristic of her genius as the civic was of Greece or the philosophic of India. The connection that he has shown between English Naturalism of the 18th century and the interest in Chinese art displayed by the younger painters of the era (Pp. 106-109) is worthy of further study ; and the two illustrations on Pp. 108 and 109 are conclusive. The illustrations indeed have been chosen with discrimination and form a suggestive collection. The author has assigned much less significance to Buddhistic influence than is customary or Dr Bagchi will allow. He also does not refer to the influence of Chinese poetry on some modern English poets ; the preciosity to which so much value was attached in China being much in evidence in these latter-day English poets. We will pay the author the compliment of wishing that a similar book could be written by someone exhibiting China's relations with India and their reciprocal influence on each other. If such a book were to even approach the readability of Sir John's, we will not complain.

D. G.

New Road 1944, —Edited by Alex Comfort and John Bayliss. Published by the Grey Walls Press, London. Pp. 278. Price 10*s.* 6*d.*

As the editors explain in their explanatory title, the volume is intended to exhibit new directions in Art and Letters. It is an anthology and makes excellent reading. We appreciate the endeavours at revaluation in the selected essays, and Mr Comfort's pugnacious perspicacity challenges our deepest prejudices ; his concluding statement—that "if God created the world, He did it as a protest against His own limitations" is somethieng more than a defiant paradox. We are glad that the editors had the good fortune of coming across the writings of Prem Chand, though in what they found him symptomatic of 'new directions' is far from being clear. Prem Chand touches our deepest feelings, but he continues old traditions within strictly conservative limits. Perhaps the editors were attracted by the revolt of the under-dog which motivates also that poignant

essay 'No such House'. We confess we cannot be equally enthusiastic about the selected poems. They have the vice of an undefined esotericism which secludes so much of modern poetry from popular understanding. We wish that poets would begin to condescend to come down from their stilted heights and speak to us in a language we understand as it is the muscular phrases seem to be reaching out to some big purpose only to be frustrated by a nervous breakdown at the psychological moment. There is too much effort and too little effect. The anthology is significant in that it shows the spirit of the modern world in the throes of travail.

D. G.

Principles of Physical Geology.—By Arthur Holmes, D.Sc., F.R.S., Regius Professor of Geology and Mineralogy, University of Edinburgh. Published by Thomas Nelson and Sons Ltd., London. Pp. 509. Price 30 Shillings.

Sir Thomas Holland once said that a text-book should be ten years behind the times, meaning that it was only after that period that new theories could be regarded as having been thoroughly tested, and retained or discarded as experience dictated. This book is rather more up-to-date than that ; but the newer theories, especially those relating to the internal structure of the earth, and the mechanism of mountain building and vulcanism, give rise to so much stimulating thought, that the author may be excused their treatment in an elementary text book.

The book is divided into three parts. The first part presents what the author terms a preliminary survey, in which the principles of physical geology are summarised, and the materials of the earth's crust described. This part serves as an introduction to the more detailed treatment that follows. The second part deals with external processes and their effects ; while the third part discusses the internal processes of the earth and their surface expression. The latter part includes such subjects as earthquakes, earth movements and the resultant mountains, plateaus and rift valleys, volcanic activity, and continental drift, and the student will probably find it the most interesting part. Though much of this part is of a speculative nature, and necessarily so, since it deals with processes originating deep within the earth's body and on a scale so vast that it is doubtful as to how far the results of laboratory experiment can be held to apply, modern methods of investigation have made such progress during recent years that the depths of the earth are less inscrutable than before, though still the subject of much controversy.

Many students of Indian geology must have found it difficult to understand how it was that at approximately one and the same time a state of tension existed in one part of India, permitting the extravasation of immense quantities of molten lava, while in a contiguous part conditions of compression existed resulting in the intense folding of the earth's crust, and the piling up of the great Himalayan range. Holmes is an advocate of the hypothesis of sub-crustal convection currents to explain such facts. He writes: "Where currents are flowing horizontally along the surface of the crust, they exert a powerful drag on the latter, throwing it into tension where they diverge and into compression where they converge." The difficulty, however, is to explain how convection currents start in the first place, and when started how they can lead to such a similar repetition of events on so many occasions. One gets the impression that speculative hypotheses are being invented to match the requirements, against which indeed Holmes utters a word of warning. Much of this third part of the book is of this nature ; but because it is so controversial it is also interesting, and should stimulate the student to think for himself.

Perhaps the outstanding feature of the book is its fine collection of plates and text figures, which are refreshingly new and reflect the author's method of teaching. These illustrations are taken from all over the world (except India), though the largest number come from the British Isles. This may be justified by the fact that there is no country in the world of so small a size which displays so complete a record of geological history, or in which the relation between the geology and the physical geography is so clearly demonstrated. Nevertheless, let us hope that the time will soon come when it will be possible to provide such a book with illustration largely taken from Indian sources.

At the end of each chapter there are given suggestions for further reading. If only half of the books suggested were in the library of every geology and geography department in India, they would make a valuable collection suitable for the students' use.

Perhaps the main criticism that can be made of the book is that some subjects might have received more detailed treatment. However, the price of the book is already thirty shillings, and that is quite enough to expect any student to pay.

As a text book for students of geology and geography up to the B.Sc. standard the book is strongly recommended. If the student purchases this book, and one of the well known books on Indian geology, he will be well provided with reading matter concerning the broader aspects of his science, to supplement his lectures ; while the book should also prove of interest to students of other sciences who wish to have a general idea of modern theories regarding the structure of our earth, and regarding the origin of the surface features displayed upon it.

W. D. W.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

USE OF MAHAJAN'S OPTICAL HYGROMETER

In the previous papers, the author has dealt with the construction,[1] working,[2] time lag,[3] humid fatigue,[4] and humid hysteresis[5] of Mahajan's Optical Hygrometer. Now, in order to have accurate results with the use of the same, the author has found that the following precautions which are platitudinous and commonplace, should be duly considered, while using this instrument.

1. In order to get rid of the errors due to time lag and hysteresis, a considerable time should be given to a hygrometer to reach its steady state so that the light spot is dead stop on the vertical scale.

2. If the instrument is subjected to much heat, such as, direct sunlight, or steam, and that if it is wet by exposure to rain or direct water-contact it requires readjustment. Therefore it should neither be kept near water nor any source of heat.

3. When the rod supporting the two pans turns upside down or dips too much it indicates either super-saturation or absolute dryness. In the former case there are minute particles of water in the air and in the latter case there is no trace of humidity in it. When this instrument is exposed to such an air, the adjustment of the apparatus is affected and hence it requires readjustment after that.

4. This instrument has a casing for protecting it from strong breeze of air which may upset its adjustment. But this casing also obstructs the free passage of the air. Therefore considerable time should be given to it to indicate a steady and correct reading by letting the light spot to come to rest.

5. The instrument should be placed in such a way that a current of air from a fan or otherwise enters the casing and comes out through the perforations at its base for the humidity is much more local than is generally supposed. By this process the period of time lag can easily be reduced from 20 minutes to even less than ten minutes.

6. To obtain the mean humidity of a room, the instrument should not be placed near the walls of a room for they are good absorbers of moisture from the air. The air at one inch from a cold wall is about 10 per cent more humid than what it is about one foot away.

7. The hygrometer should not be placed near books, lumber furniture and the like as they generally affect the air near them, being good absorbent material.

8. Sometimes when the temperature is falling rapidly, practically all solid substances radiate heat rapidly and in extreme cases, the dew is deposited if the surface is non-absorbent, because the air at the surface is contracted by the cold, the saturation point is reached, and the water is precipitated. Thus the adjacent cold surfaces, even the casing of the hygrometer tends to moisten the air and the humidity percentage goes up with the cooling of air. Therefore some allowance should be made for this fact.

9. A rapid circulation of air can easily disperse the local humidity of the apparatus and will also equalise the humidity of the air in the room. Thus the instrument should be placed in a current of air from a fan and then more accurate reading will be obtained.

The author is indebted to His Highness' Government, Patiala for providing facilities to conduct this work in the Physics Research Laboratory, Mahendra College, Patiala.

L. D. Mahajan.

Physics Research Laboratory,
Mahendra College, Patiala,
10-12-1944.

[1] L. D. Mahajan, "The Optical Hygrometer", *Current Science*, *9*, 100, 1941.
[2] ———— "The Optical Hygrometer and its working", *Indian Journal of Physics*, *15*, 425-432, 1941.
[3] ———— "Time lag and Humid Fatigue of Hygrometers", *Indian Journal of Physics*, Calcutta (in press)
[4] ———— "Humid Fatigue of Hygrometers", *Current Science*, *13*, 73-74, 1944.
[5] ———— "Humid Hysteresis of Mahajan's Optical Hygrometer and Others", *Indian Journal of Physics*, Calcutta (in press).

PHARMACOGNOSTIC STUDIES ON "IPECACUANHA"

The well known and highly important drug 'Ipecacuanha' is obtained from the roots of the plant *Cephaelis Ipecacuanha* (Brot.) A. Rich. (*Psychotria Ipecacuanha* Stokes.). This plant is a small shrub, indigenous to Brazil and is cultivated there.[1] It is

also cultivated in Selangor, in Federated Malaya States.[2] In India it is cultivated to a small extent in Bengal at Mungpoo in Darjeeling District. The root of this plant is the chief source of the alkaloid emetine and the drug is emetic, diaphoretic, one of the best expectorants and an excellent remedy for treatment of amoebic dysentry.

The present pharmacognostic study was undertaken to determine the particular age of the plant when the alkaloid content reaches its maximum limit, in order to ascertain the proper time of collection. The materials were obtained from Mungpoo in Darjeeling district where it is cultivated under Government supervision along with cinchona and 1-4 years old plant materials were collected.

The roots from plants collected at the end of 1st and 2nd year appeared to be thinner than those obtained from 3 and 4 years old plants. In 1 and 2 years old plants, most of the roots, though annulated showed that the ridges were not fully round and did not completely encircle the root. The average diameter of the roots varies from 0·4 to 0·6 mm. according to age of collection. Besides the external appearance the roots of 1 and 2 years old plants are found to be infested with a number of very thin thread like rootlets whose number gradually decreases as the plants grow old. In the 3rd year of collection the roots are found to be well developed with the ridges distinctly rounded and completely encircling the root. The roots of 4 year old plants are alike to those of the previous year except that the bark in several places is more separated from the root. The less annulated structure of the root and the presence of a number of fibrous non-annulated rootlets are special features of samples of earlier collection.[3]

The diagnostic microscopical characters[4] as found in the roots are thin brown elongated cork cells filled with brown granular material. Below this the secondary cortex is found to be exceptionally wide and composed of thin walled parenchyma mostly filled with starch grains. In it there are also some scattered cells containing needle shaped crystals of Calcium Oxalate 30-80μ long. The starch grains are usually compound with from 2-8 components. Sclarenchymatous cells or fibres are absent in the bast ring. The xylem is characterised by the presence of perforated tracheids, small tracheal vessels and wood fibres. The structure of secondary or tertiary roots in plants of different ages are more or less alike but the difference in structure of primary root in plants of different ages is quite well marked as the number of rings of wood in the xylem varies from 1-4 according to the age of collection. Microchemical tests with hydrochloric acid and potassium chlorate as well as other reagents showed the presence of emetine in the bark and its absence in the xylem and these reactions were more marked in three and four years old roots as compared with those of 1st and 2nd year old plants.

A comparison of the dry weights of the amount of roots per plant is stated below:—

	Total amount of roots per plant.	Average weight of roots per plant.
1st Year	2·021 to 4·952 gms.	3·5 gms.
2nd ,,	9·15 to 17·425 ,,	13·28 ,,
3rd ,,	20·145 to 24·785 ,,	22·46 ,,
4th ,,	18·85 to 25·43 ,,	22·20 ,,

The roots of the plants of these different age groups (*i.e.*, 1-4 years of collection) were subjected to chemical analysis at 3 different places and the results are tabulated below:—

	1st Analysis		2nd Analysis		3nd Analysis
	Total Alkaloid	Non-phenolic Alkaloid	Total Alkaloid	Non-phenolic Alkaloid	Total Alkaloid
1st Yr.	1·45%	1·18%	2·30%	1·20%	1·95%
2nd	1·70%	1·21%	2·33%	1·24%	2·00%
3rd	2·33%	1·40%	2·50%	1·35%	2·15%
4th	2·14%	1·21%	2·60%	1·35%	2·25%

B.P. (1932) Addendum VI prescribes that ipecacuanha root should contain not less than 2% of the total alkaloids and not less than 55% of these should consist of non-phenolic alkaloids calculated as emetine.[5] From the above results it is found that the roots of 3 and 4 years old plant give an amount of alkaloid conforming to the B.P. standard. According to results of analysis No. 1, the highest yield of emetine is in the 3rd year of collection and according to analysis No. 2 highest yield is obtained in both 3rd and 4th year of collection. It is therefore feasible that even when the non-phenolic alkaloid content is the same in the 3rd and 4th year the crop should be harvested from 3 years old plants with better advantage.

It is also to be noticed that the percentage of total alkaloids is less than that obtained from roots of 2½ years old plants grown at Serdang in the Selangor State in the Federated Malaya States where as much as 3·1% of total alkaloids and 1·6% of emetine have been obtained. It is therefore worth-while to carry on further experiments to improve the cultivation of this very important medicinal plant with a view to get a better yield of alkaloids.

We are indebted to Messrs. Bengal Immunity Co. Ltd., for providing the necessary fund to carry on the work, to Mr S. C. Sen, B.A. (Cant.), B.Sc. (Cal.), A.M.I.Chem.E., Principal Quinine Officer, Government of India for his kindness in sending the samples of roots, to Dr B. Mukerji, D.Sc., M.D.,

F.N.I., Director, Biochemical Standardisation Laboratory, to Mr S. Mukherjee, M.Sc., of Bengal Immunity Co. Ltd., and to Professor (Miss) A. Mukherjee, M.Sc., of Lady Brabourne College, for their kind help in analysing the samples.

The details of the paper will be published elsewhere.

S. N. Bal
S. C. Datta

Pharmacognosy Research Laboratory,
Industrial Section, Indian Museum,
Calcutta, 24-1-1945.

[1] Bal, An outline of pharmacopoeial drugs of vegetable origin.
[2] Bal, Ipecacuanha, *Ind. Jour. of Phar.*, 2, No. 1, 1940.
[3] Trease, A Textbook of Pharmacognosy.
[4] British Pharmaceutical Codex, 1934.
[5] British Pharmacopoeia, 1932, Addendum VI, 1943.

RUPTURE OF WATER DROPS OVER LIQUID SURFACES

It has been reported elsewhere[1] that when drops of water of a given size are allowed to fall upon oil surfaces from gradually increasing heights, upto a certain critical value of the height, they sink into the oil as a whole but for heights greater than this critical value, they rupture into two or more droplets. This critical height depends upon the size of the drop and other physical properties[2] (such as viscosity, interfacial surface tension etc.) of water and oil. Further careful investigations of this phenomena have however revealed that in case of certain suitable size of water drops falling upon comparatively less viscous oils (or their mixtures) there are very often several critical heights for the rupture of water drops, and in between the consecutive critical values within a range of height, the drops are found to enter as whole (without rupture) into the oil.

In the actual experiment water drops of different sizes ranging in diameter from ·2 to ·5 cms. were allowed to fall on mixtures of Turpentine oil and Castor oil in different proportions by volume, ranging from 50 per cent to 0 per cent of Castor oil. The observations may be summed up in the following words:—

(1) The small size drops of the order of ·2 cms. diameter do not exhibit more than one critical height. In some cases the second critical height was located but its distance from the first critical height was fairly large—of the order of four times the value of the first critical height itself.

(2) The bigger size drops of the order of ·4 cms. diameter exhibit a number of critical heights spaced at intervals of 1 cm. approximately from the first critical height.

(3) There seems to be an optimum size of the drop for the maximum number of critical heights and as the size of the drop becomes more than the optimum value, the number of critical heights begin to decrease.

(4) The highly viscous liquids, as for example, 50 per cent Turpentine oil and 50 per cent Castor oil by volume, do not exhibit more than one critical height even with the optimum size of the drop. In some cases they exhibit a second critical height which is fairly apart from the first critical height.

(5) The less viscous liquids exhibit sometimes ten or more critical heights when experimented with the optimum size of the water drop.

Without entering into the detailed mechanism of the rupture of the water drop, it may be suggested that the rupture takes place when the drop has collided with the oil surface and when the distortion produced in it, exceeds beyond a certain limit. It is also clear that for a given size of drop falling from a given height, the amount of distortion and its speed will be more in the case of less viscous oils. This fact is supported by the experimental observation that for a given size of drop, the critical height is greater for more viscous oils, on which it is allowed to fall. The drops of water even after they have come into contact with the oil surface, will have a tendency to oscillate in the way first suggested by Lord Rayleigh.[3] These oscillations will have a certain time period which will depend according to Rayleigh only upon the size of the drop and the interfacial surface tension between the oil and the water. It is however, not unlikely that in this case the viscosity of the oil may also affect the time period. In any case, it appears that the presence of a number of critical heights for rupture is due to the tendency of the oscillation of the drop to prevent its rupture. When the drop assumes a spherical form during its course of oscillation, it is much more stable and hence rupture may not be possible. The first critical height for the small size drops is greater than for the large size drops. There are several critical heights for the rupture of water drops and in between these consecutive critical values, the drops do not rupture but sink as a whole. The drop in its course of oscillation may assume a spherical form (from the elliptical form say) and here its potential energy is a minimum and is in a more stable form. Hence the distortion produced after collision with the oil surface is not sufficient to rupture a spherical drop (while it may be sufficient for an already distorted elliptical drop). So it is the tendency of the oscillation of the drop to assume either the sperical or elliptical form which prevents or produces the rupture. It has been observed experimentally that the first critical height for the small size drops is greater than that for the large size drops. As the

former fall through a greater height, the kinetic energy generated at the expense of the potential energy is also greater—sufficient enough to produce rupture even in the most stable (spherical) form and hence they will not exhibit more than one critical height. Their kinetic energy in relation to its surface energy is great enough to produce rupture even in the most stable (spherical) form and hence they will not exhibit more than one critical height. In case of more viscous oils, the tendency of their oscillation will be damped and hence the chances of more critical heights will become less.

B. N. Singh
B. K. Sahay

St. Xavier's College,
Ranchi, 12-1-1945.

[1] Singh and Sinha, *Sc. Coll. Phil. Soc. Mag.*, 1944.
[2] Singh and Sinha, *Curr. Sci.*, *13*, 157, 1944.
[3] Rayleigh. *Proc. Roy. Soc.*, *29*, 71, 1879.

AMMONIUM SULPHATE *VS.* AMMONIUM NITRATE

There has been a big stir amongst the Indian scientists, industrialists and agriculturists, recently, on the decision of the India Government to erect plants for the manufacture of 350,000 tons of ammonium sulphate per year, to be used as a fertiliser. For the manufacture of the ammonium sulphate India will have to be dependent mainly on the foreign imported sulphur, which under unfavourable circumstances, as at the present time, may jeopardise the whole industry with a consequent heavy blow on the agricultural products of the country.

Is it not possible to use ammonium nitrate in place of ammonium sulphate, if not wholly, at least partly? Will any scientist enlighten as to what are the objections in using ammonium nitrate as a fertiliser? Ammonia can be prepared from the nitrogen of the air and hydrogen from water; this ammonia can be oxidised to nitric acid with consequent production of ammonium nitrate. So by substituting ammonium nitrate in place of ammonium sulphate India can become independent of foreign resources.

Large amounts of ammonium nitrate are being used as fertiliser, both directly and as an ingredient in mixed fertilisers in the United States of America. Since ammonium nitrate like sodium nitrate is a supporter of combustion, there are certain hazards in handling it, and storing of the material. The Agricultural Department of the U. S. Government are instructing the people, as to the possible hazards, and and how to avoid them. A 50/50 per cent ammonium nitrate and sulphate mixture has found a favourable market since there is practically no hazard in handling it. Other mixtures of ammonium nitrate impregnated with inert fertilisers or materials have also been marketed.

Though ammonium nitrate is used as a high explosive, it requires a high velocity detonator in sufficient quantity to energize the mass. Under favourable conditions of pressure, rapid heating and retention of heat, it may be exploded partially from heat alone at 207°C. to 350°C. or completely above 350°C., but these circumstances are unusual in practice. As a supporter of combustion it demands only that it should not be stored near wooden structure or other combustible materials. It should not be stacked near copper which reacts appreciably with molten ammonium nitrate producing nitrite, less stable than nitrate, and which has increasing tendency to violent conflagration or explosion.

So with above precautions it seems, that at least 50 per cent of the ammonium sulphate can be replaced by ammonium nitrate thus making us 50 per cent independent of foreign resources, and under unusual circumstances the whole of the other 50 per cent ammonium sulphate can be dispensed with by replacing with other inert fertilisers or inert materials.

N. K. Sen Gupta

Chemical Corporation of India,
6, Kalicharan Ghosh Road,
Cossipore, Calcutta.
12-1-1945.

ON THE DESCRIPTION OF THE INFLORESCENCE OF *RICINUS COMMUNIS* LINN.

While examining the morphological details of the inflorescence of *Ricinus Communis* Linn., the present writer found certain discrepancies in the descriptions as recorded by Hooker[1] and Prain.[2]

Hooker records:—"Flowers large, in terminal subpanicled racemes, monoecious, apetalous, *upper male crowded, lower female.*"

Prain also follows thus:—"Flowers monoecious, large in terminal, subpaniculate racemes, perianth simple; *males higher up, crowded, females below*". (Italics ours).

From the numerous observations made both from the specimens occurring in nature and from the herbarium sheets, it is evident that the female flowers are borne above and the male flowers below on the rachis, *i.e.*, just the reverse as described by Hooker and Prain. Other descriptions stand correct. The

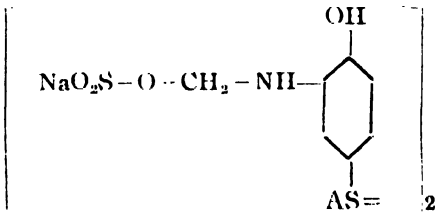
writer, therefore, wishes to record his correct observations for whatever they are worth.

Botany Department, R. M. DATTA
J. I. College, Dacca.
1-2-1945.

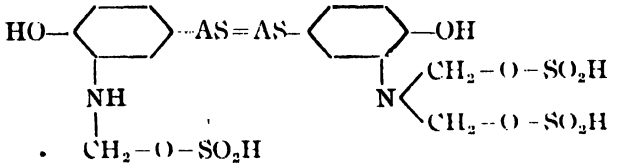
[1] Hooker, Sir J. D.—*The flora of the British India, 5,* 457, 1890.
[2] Prain, D.—*Bengal Plants, 2,* 951-952, 1903.

ON THE CONSTITUTION OF SULPHARSPHENAMINE

SULPHARSPHENAMINE, a drug of choice for the treatment of syphilis, is described in the B.P. (1932) as consisting mainly of disodium 3 : 3′-diamino-4 : 4′-dihydroxy-arsenobenzene - N : N′-dimethylene - bisulphite (I). Dyke and King[1] suggested that the commercial product corresponds to a sodium salt of the N : N : N′-trimethylene sulphurous acid (II).



(I)



(II)

The fundamental difference between the two formulae lies in the fact that in the former the parent compound (3 : 3′—diamino—4 : 4′—dihydroxy-arsenobenzene) is reacting with 2 mols of formaldehyde, whereas in the latter it has reacted with three. As such, the above parent compound was prepared,[2] washed with sodium bicarbonate solution to remove any sulphonic acid derivative,[3] subsequently dissolved in minimum amount of caustic soda, and the resulting solution was filtered from any insoluble impurities. All these operations were carried out in an atmosphere of nitrogen. The filtrate, containing the sodium derivative of the above parent compound was treated with the requisite amount of pure hydrochloric acid for conversion to salvarsan dihydrochloride. The resulting solution was reacted with formaldehyde, in one case with 2 moles and another with three. Both the reaction mixtures were subsequently reacted[4] with the requisite quantities of sodium bisulphite solution freshly prepared. In the latter case a product was isolated, containing 18·6% arsenic, which, on biological assay, did not pass the test for local irritant effect, as laid down in B.P. But products isolated from the mixture where the salvarsan dihydrochloride solution has been reacted with 2 mols of formaldehyde are being found to comply rigidly with the tests for toxicity, therapeutic potency and other specifications as laid down in B.P. The drug prepared in this way contains 20·—20·5% arsenic, 2·5—2·75% sodium chloride and a trace of free sodium bisulphite (or sulphite).

Further, in order to verify the chemical nature of the product, a concentrated aqueous solution of the drug as obtained above was slowly treated with glacial acetic acid in the cold and the precipitated free sulphurous acid was filtered and washed with acetic acid and with small quantity of cold water. It was finally dried in *vacuo* over sodalime at 120° (Found : As,[5] 26·58 ; N (Dumas), 4·96 ; S (Carius), 11·16. $C_{14}H_{16}O_8N_2S_2AS_2$ requires AS, 27·04 ; N, 5·05 ; S, 11·55 per cent). These analytical figures conform rigidly to the formula (I ; II for Na). Several other samples of this acid were similarly prepared and analysed, and in each case the analytical figures point to the formula (I). It is, therefore, evident that the drug sulpharsphenamine has the constitution (I), and because of the presence of traces of free sodium bisulphite (or sulphite) and sodium chloride, its arsenic content has been lowered from 25% (as required by formula I) to approximately 20% (as found above and as also specified by B.P.). It should be noted that these impurities crop in course of preparation of the drug. A sample of sulpharsphenamine (international standard powder) has also been found in our hands to contain traces of sodium chloride and of free sulphite.

Our thanks are due to Dr U. P. Basu, for his kind interest in this investigation and to Dr A. N. Bose for carrying out the pharmacological examination of various samples of the drug prepared in this laboratory.

T. N. GHOSH
S. N. MITRA

Bengal Immunity Laboratory,
Calcutta, 7-2-1945.

[1] Dyke and King, *J. Chem. Soc.*, 805, 1935.
[2] Kober, *J. Amer. Chem. Soc., 41,* 442, 1919.
[3] King, *Trans. Chem. Soc., 119,* 1107, 1921.
[4] Voegtlin and Johnson, *J. Amer. Chem. Soc., 44,* 2573, 1922.
[5] Gray's method (*J. Chem. Soc., 128,* 3181, 1926) for the estimation of antimony in organic compounds has been utilised for the estimation of arsenic and has been found to be suitable.

EFFECT OF WATER VAPOUR IN THE ATMOSPHERE ON THE PROPAGATION OF ULTRA-SHORT RADIO WAVES

The applications of ultra-short radio waves have become remarkably wide particularly in connection with television, aviation and radio sounding balloons. Usually it is assumed that if these waves are allowed to radiate up, they will travel straight through the lower atmosphere or troposphere and on further progress will peneterate the upper atmosphere or ionosphere, and may ultimately be lost for useful reception. Further it is often presumed that such waves may not reach a long distance beyond the optical horizon. Receptions of such short waves at fairly long distances with associated fadings have however been reported by various investigators[1-7] and incidentally it has been suggested that in addition to diffraction of the waves as calculated by Epstein,[8] the lower atmosphere may be responsible for fading of the signals and also for their long distance travel by bending them along the curvature of the globe. The meteorological elements such as, temperature, pressure and water vapour in the atmosphere have been considered for possible agencies for bending such waves. It may be pointed out, however, that any sudden change in the above elements within a small region of the atmosphere may have a considerable effect on the mode of propagation of these ultra-short waves, as the dimensions of the region may be comparable to the wavelength.

Hulburt[9] has shown that if the air be dry in the atmosphere, there must be an upward increase of temperature of 2·9°C per 10 metres for bending such waves along the curvature of the earth. Such large temperature inversions are however rather rare phenomena. The effect of pressure change also appears to be insignificant unless it is of very high magnitude.

The purpose of the present communication is to show that the presence of water vapour in adequate quantity to saturate the air in the lower layers of the atmosphere can cause considerable bending of the ultra-short waves, necessary for propagation along the curvature of the earth and even more. It may be mentioned that such amounts of water vapour may be found in many places in India in the pre-monsoon and monsoon seasons.

For simplicity, we may assume that the wave while travelling gradually from a comparatively drier region of the atmosphere to such a humid layer, bends in a circle and the radius of curvature can be calculated by Fermat's principle, from the equation,

$$\frac{K}{2}\frac{1}{\Delta X}\frac{\Delta K}{\Delta X}$$

where K = dielectric constant of the atmospheric layer,

$\frac{\Delta K}{\Delta X}$ = change in dielectric constant due to water vapour within a height ΔX, and

r = radius of curvature of the path of wave.

The signs of the right hand expression in the above equation indicate whether the signal will bend towards or away from the earth.

Two possible cases have been considered for calculation. Firstly, when the air is saturated up to a certain level and contains water in the form of vapour only and above the layer, there is perfectly dry air ; and secondly, when the lower moist layer is raised by one kilometer and water is partly in the form of vapour and partly in the form of condensed water drops. Assuming the change in the dielectric constant of air ΔK due to added water (liquid or vapour) is proportional to the amount of material in one c.c. of the medium, it can be shown that $\Delta K = 12{\cdot}7\ m_1$ when water is in vapour form and $\Delta K = 80{\cdot}0\ m_2$ when it is in liquid form, where m_1 = amount of water vapour in gm/cc. and m_2 = amount of liquid water in gm/cc.

The calculated values of radii of curvature for bending of the waves in the above two cases are shown in the last column of Tables I and II repec-

TABLE I

Ht. in km. above ground	Temp. °C	Amount of water vapour in saturated air (m_1) in gm/cc.	Change in dielectric constant $\Delta K = 12{\cdot}7\ m_1$	Radius of curvature of the path of wave (r) $\times 10^3$ km.
1	28·0	$27{\cdot}234 \times 10^{-6}$	$345{\cdot}8 \times 10^{-6}$	1·44
2	20·0	$17{\cdot}300 \times$,,	$219{\cdot}8 \times$,,	2·27
3	12·5	$11{\cdot}006 \times$,,	$139{\cdot}8 \times$,,	3·58
4	1·5	$6{\cdot}579 \times$,,	$83{\cdot}6 \times$,,	5·98
5	1·5	$4{\cdot}313 \times$,,	$54{\cdot}8 \times$,,	9·12

TABLE II

Ht. in km. above ground	Amount of water in vapour form in gm/cc. m_1	Amount of water in droplet form in gm/cc. m_2	Change in dielectric constant $\Delta K = 12{\cdot}7\ m_1 + 80{\cdot}0\ m_2$	Radius of curvature of the path of wave (r) $\times 10^3$ km.
2	$17{\cdot}300 \times 10^{-6}$	$9{\cdot}934 \times 10^{-4}$	$1014{\cdot}5 \times 10^{-6}$	0·49
3	$11{\cdot}006 \times$,,	$6{\cdot}294 \times$,,	$643{\cdot}3 \times$,,	0·78
4	$6{\cdot}579 \times$,,	$4{\cdot}427 \times$,,	$437{\cdot}8 \times$,,	1·14
5	$4{\cdot}313 \times$,,	$2{\cdot}266 \times$,,	$236{\cdot}1 \times$,,	2·12

tively. Representative temperatures in different layers for above calculations have been taken from normal temperatures in the month of May over Poona. For calculating $\Delta K/\Delta X$, the thickness of the layer of discontinuity has been assumed to be 250 metres. The change in dielectric constant when water is solely in the form of vapour is shown in the fourth column of Table I and the same for water in vapour and droplet form together is shown in the same column of Table II.

It will be noticed from the last column of Table I, that in the normal atmosphere over Poona in the month of May, saturation at a level of 3 to 5 km. will be capable of bending ultra-short waves along the curvature of the earth, assuming the radius of the earth to be about $6{\cdot}36 \times 10^3$ km. The same column in Table II shows that such bending may occur even much higher above 5 km. due to the upward rush of humid layer. Further, it may be pointed out that in the second case pronounced bending will occur at lower levels which may be considerable enough to cause fading of signals and also give rise to measurable errors in actual bearings while locating an aircraft or a radio-sounding balloon.

The author's sincere thanks are due to Diwan Bahadur Dr K. R. Ramanathan, Superintending Meteorologist, for his helpful interest in the present investigation.

S. S. BANERJEE

India Meteorological Department,
Poona,
7-2-1945.

[1] M. Marconi, *Proc. Roy. Inst. of G. B.*, *27*, 509, 1933.
[2] J. C. Schelleng, C. R. Burrows and E. B. Ferrell, *Proc. Inst. Rad. Eng.*, *21*, 427, 1933.
[3] A. Clavier, *L'Onde electrique*, *13*, 101, 1934.
[4] R. A. Hull, *QST*, *19*, 13, 1935.
[5] C. R. Burrows, A. Decino and L. E. Hunt, *Proc. Inst. Rad. Eng.*, *23*, 1507, 1935; *26*, 516, 1938.
[6] C. R. Englund, A. B. Crawford and W. W. Mumford, *Bell Syst., Tech. Journ.*, *14*, 369, 1935.
[7] K. G. Maclean and G. S. Wickizer, *Proc. Inst. Rad. Eng.*, *27*, 501, 1939.
[8] P. S. Epstein, *Proc. Nat. Acad. Sci.*, *21*, 62, 1935.
[9] E. O. Hulburt, *Proc. Inst. Rad. Eng.*, *23*, 1492, 1935.

WHY THE EARLY FRY OF CARPS DO NOT THRIVE IN PERENNIAL PONDS OR IN FRESH-WATER *BHERIS* NEAR SEWAGE CANAL, CALCUTTA

THE tiny little fry of carps when transferred to a big perennial pond soon after their hatching do not thrive well and in most cases leave no trace of their existence. This is due to (1) the existence of predacious adult fish which may devour them, (2) the fry that we generally get as carp fry are not exclusively as such but contains many predacious fish fry as these fry are collected in lots, (3) the food of these early fry which is carnivorous is comprised of protozoon, tiny little crustacea, and small insect larvae, etc., which do not thrive in such perennial waters, (4) most of these perennial waters contain many weeds, grasses, dense higher aquatic plants which really become a hindrance to tiny little fry hunting their animal food as these are generally very fast in locomotion, or the carp fry fall an easy prey for the overgrowth of vegetation.

In the fresh-water *bheries* (former salt-water) in the vicinity of Calcutta sewage water canal the general complaint is that tiny little fry of carps do not thrive when put in these *bheries* fed by sewage water. So in all these *bheries* instead of tiny little fry they put *chala* fish which are really either stunted adolescent stage of the previous year or fingerling stage of the year concerned. We all know that it is the tiny little fry that is more economical than either fingerling or adolescent stages.

As regards the first two points of reasons for not thriving the tiny carp fry there is no dispute. Regarding the third point I performed an experiment with two ponds, one seasonal and another perennial. In both these ponds manuring were performed. In the seasonal, ploughing, administration of dried cowdung, mustard oil cakes and eventually after the accumulation of rain, bundles of straw and dried water hyacyinth were put. The culture of unicellular algae, protozoon and crustacea were copious. In the perennial pond dried cowdung, bundles of straw and dried water hyacinth were put but the culture were not like the other one. Regarding the fourth point I asked a few owners of the fisheries to eradicate the grass of their fishery specially their dormant roots in summer when most of them become dry. Over and above they were advised to put fire to these grass roots. This prevents excessive growth of vegetation which feeds on sewage. In the *Ilanakhali* Fishery in the Rajnagar area they acted according to the above suggestion and got good result. In former years they lost almost the whole of their tiny fry which they put in their fishery area without eradication of their grass or other weeds and when these fry were fed with sewage water. The result was vigorous growth of vegetation which hinder the access to their animal food and also their self-protection. But this time there were no such hindrance and they got a very high percentage of the fry with their desired growth.

Zoology Department,
Calcutta University, H. K. MOOKERJEE
7-3-1945.

Physics

Quantum Theory of Radiation Damping

R. C. MAJUMDAR

IT is well known that a moving electron experiences a sort of resistance due to its own electromagnetic field, similar to that of a body vibrating in the air and producing sound waves. This resistance is called the radiation damping. The classical theory of radiation damping has been worked out by Lorentz and Dirac. The quantum mechanical calculations of the radiation damping and its correspondence with the classical theory sets a limit of radiative processes involving energies not exceeding 100 million volts. It is, however, found that in almost all problems the radiation damping is in general quite small and does not lead to any divergent difficulties even if neglected.

But a different situation is met with in the theory of mesons, the new type of particles recently discovered in cosmic rays. It has been noticed that the quantum mechanical results involving mesons interacting with the electromagnetic as well as with the neutron and proton (which we shall call nucleon) are in general highly divergent. The cross section increase with increasing energy of the incident particle. This behaviour seemed so peculiar that even the correctness of the fundamental equations of the meson field was questioned. But it was for the first time realised by Bhabha that this increase is essentially due to the neglect of the effect of radiation damping. In meson theory we are not only concerned with the usual radiation damping pertaining to the scattering of light by meson but also the radiation damping when the meson is scattered by the neutron and proton nucleon. The radiation damping in the latter case represents the reaction of the meson field emitted by the nucleon on the motion of nucleon itself. The quantum theory of radiation damping which has been described in the present address confirms to Bhabha's classical calculations in showing that the anomalous results for the process involving mesons disappear. It is also discussed that the correct theory of radiation loss of meson, including the effect of radiation damping, will give valuable information regarding its spin. It is believed that the theory of radiation damping when fully developed will be of profound significance in our understanding of the nature of fundamental particles and the phenomena in the field of nuclear and cosmic ray physics.

Zoology & Entomology

Protozoa Affecting the Health of Domesticated Animals in India

H. N. RAY

PROTOZOAN parasites infect all domesticated animals and factors to be borne in mind while devising methods of control or therapeutic treatment of such protozoal infections are: (1) *Geographical distribution*: When an intermediate host is involved in transmission, the disease is confined to the area which favours survival of the vector ; but when the infection spreads by contact, introduction of a single affected host is sufficient to establish the infection into a clean area, (2) *Reaction of the host to infection*: recovery from a protozoan infection does not mean complete disappearance of the parasite from the system of the host which exhibits a tolerance to the parasite for a long period. Such animals are called 'carriers', which are potential sources of danger to other animals, (3) *Treatment*: serum or vaccine treatment are of little or no value in protozoan infections. Control measures based upon natural history of the disease have played a very important role in stopping the further spread of infection.

Spontaneous amoebic dysentery amongst hounds

of Ootacamund was for the first time noted in India by Ware. The organism concerned is *Entamoeba histolytica* and the potential source of infection is man. *Leishmania* causes cutaneous leishmaniasis in dogs and bullock, and a few cases are reported from India. *Trichomonas* are known to produce sterility, abortion, and pyrometra in cattle and enterohepatitis in fowl. Cases of giardiasis caused by *Giardia* in dogs of foreign breed were encountered at Mukteswar and one case was successfully treated with quinacrine.

Amongst the domesticated animals in this country flagellates of the genus *Trypanosoma* are recorded. *T. theileri* is non-pathogenic, while *T. evansi* is the causative agent of a most virulent type of trypanosomiasis amongst horses, mules, donkeys, camels, elephants, cattle, buffaloes, dogs, cats etc. *T. equiperdum* is the cause of dourine in horses and was known to occur in India but has been stamped out completely by the Livestock importation act IX of 1898 (Glander's & Farcy act) being imposed on this disease.

Indian equivalent of the disease caused by *T. evansi* is 'surra' meaning rotten or putrid. It has been taking a very heavy toll of our livestock for a long time. Salihotra appears to have recognised this condition in Indian horses perhaps as early as 700 B.C. and the credit of discovering *Trypanosoma* of surra goes to Evans who in 1880 reported that mules and camels at Dera Ismail Khan, were affected with this disease under natural conditions.

Transmission of surra from animal to animal is purely mechanical by means of species of biting flies (Fam. Tabanideae), and probably also mosquitoes in some cases. Under the act the affected animals have to be seized and destroyed. Drugs such as Naganol, Antrypol, and Moranyl have been found very effective in cases of surra. But recent observations have shown that neither slaughter nor treatment of clinically affected animals alone can be expected to check the disease as these measures cannot deal with the latently infected animals which spread the disease. It has been found by Dr Ray that when 0·1 c.c. of surra antigen is injected intradermally into experimentally infected hill bulls a local reaction characterised by a swelling which is hot, tender and oedematous is produced in 6-9 hours while in healthy animals the swelling is less marked, nodular, hard and circumscribed. The biological test subsequently performed have corroborated the above findings. Thus, for eradication of the disease from this country a three-pronged attack is necessary, *viz.*, (1) detection of latent cases of the disease both during the surra season and when surra is absent, (2) adequate treatment of such cases and of clinically affected ones, (3) control of biting flies.

Eimeria, several species of which are pathogenic, produce diarrhoea or dysentery, emaciation and anaemia, which in acute cases causes death of the host.

'Red water' fever in dogs, cattle, sheep, horses etc. is produced by members of the genus *Babesia*. The disease is characterised by high fever, great destruction of red blood corpuscles with haemoglobinuria, jaundice, profound anaemia and finally paralysis and death.

In the members of the genus *Theileria*, schizogony takes place within the endothelial cells of capillaries of the internal organs. Such schizonts are known as *Koch's blue bodies*. Pathogenic species in this country is *T. annulata* which have two strains, one the Mukteswar strain, affecting young and adult cattle and the other 'J' strain producing fatal mortality in calves. The disease is transmitted by ticks and chemotherapeutic measures having proved of doubtful value, the disease is brought under control by tick control measures.

Concluding Dr Ray said that there remains yet wide gaps in our knowledge of life history of some of these protozoa affecting our livestock and it is important that these gaps be filled soon, as it is only from a knowledge of the life history of a parasite that we can plan an effective mode of attack. Protozoan infections, directly or indirectly are responsible for considerable economic losses among our livestock and the importance and urgency of intensive research work on such infection is emphasised if the health of our livestock is to be adequately safeguarded.

Medical and Veterinary Sciences

Ill Health With Special Reference to Ascites

S. W. HARDIKAR

IT is seen fairly frequently in Hyderabad and adjoining area in as much as about 1 in 65 of the patients seeking admission into the hospital show the presence of Ascites. It is not possible to state with accuracy how frequently it occurs in other parts of India ; it would appear to be not less frequent at least, in parts where rice forms the chief article of diet, which is poorer in quality than a more varied diet. It is not a disease by itself. It is seen most commonly in diseases of the liver but occurs also in disease of the heart, kidneys, in tuberculosis and in tumours in the abdomen and chest. But when all these causes have been excluded there remain about 15% of the cases which show no evidence of organic disease, on the basis of their response to treatment and observation after discharge these cases appear to be due to malnutrition, *i.e.*, underfeeding and defective quality of diet. It has now been proved that a diet lacking in proteins *i.e.*, flesh forming foods and vitamins will in time produce poverty of blood and diseases such as beri-beri, and in experimental animals, ascites. Famine Oedema *i.e.* accumulation of water in the skin and swelling of limbs has been fairly widely recognized as the result of insufficiency and low quality of food under conditions of war and famine. But ascites with or without swelling apart from organic disease occurring in the poorer part of the population in times considered normal in India has not as yet so clearly been recognized as due to malnutrition. The treatment in these cases consists in giving a well-balanced diet and a sufficiency of it rather than this or that particular drug though drugs are useful where special indications exist.

Evidence is accumulating to show that Cirrhosis of the liver, the disease in which ascites is most frequently seen, may itself be caused by malnutrition particularly insufficiency of proteins ; in fact it has been shown that certain fractions of the protein molecule such as the amino-acid methionine are of particular importance in this respect. Milk protein is rich in methionine. To put into very simple language, proper food and enough of it particularly the inclusion of a certain amount of milk in the diet would go a long way towards preventing the occurrence of this condition and perhaps also of more serious liver disease.

In the not very distant past as a result of brilliant discoveries in Bacteriology the tendency among investigators was to look for external causative agents of disease. Recent studies have however, shown that a large group of widespread diseases (*e.g.*, night blindness, beri-beri, pellagra, scurvy, rickets etc.,) is due to a lack of something required by the body rather than an outside harmful agent attacking it. When the views put forward here about ascites are confirmed one more condition would be added to this group.

The problem is deserving of more attention and study than it has received.

Anthropology & Archaeology

The Megalithic Culture of Southern India

A. AIYAPPAN

DR A. AIYAPPAN, in his address to the above section, pointed out that in post-war sociology local or even national problems will tend increasingly to be parts of world problems. In dealing with post-war society, the men of affairs will have to base their actions on exacter estimates of public feelings, social stresses and strains etc., than in the past. Sociologists in India will have to prepare themselves for new tasks and refine their technique on the lines of the Mass Observation and other kinds of social surveys. Referring to the problem of the aboriginal tribes of India, it is absurd, said Dr Aiyappan, to suggest that anthropologists desire to keep them "primitive". For scientific purposes a changing tribe is as full of interest as a static one. What the anthropologist wants is that reform or development

of the tribes should not mean break up as so often it has been in the past. Whatever is of value in tribal cultures should be conserved. The standard of archaeological and anthropological research and teaching in India is steadily improving. The school of archaeology, now functioning in full vigour at Taxila is a praiseworthy venture. Madras among the older universities of India is now giving considerable encouragement to anthropological studies and the arrangements made by this University to publish Canarese, Malayalam, Tamil and Telugu adaptations of the well-known textbooks of anthropology, Lowie's *Cultural Anthropology* will be specially appreciated by lovers of the subject all over the world. It is also pleasing to note that both in Bombay and Calcutta anthropological studies are being pursued with great enthusiasm. Though the Markham Report on Indian Museums made adverse comments on the very short-sighted neglect of ethnology in India, the projected National Ethnographic Museum for New Delhi, remains still a forgotten plan. If timely action is not taken now, posterity will lose the most valuable cultural material. Referring to the very important discovery made recently by Dr Wheeler, Director-General of Archaeology in India, of Mediterranean (Arettine) pottery at the Arikamedu town site near Pondicherry it was pointed out that this discovery provides a basis for dating South Indian sites on the evidence of ceramic remains. The Arikamedu site is expected to throw considerable light on the nature of early Roman contacts with India.

Reviewing the existing knowledge of rude stone monuments of South India, such as funeral mounds, underground stone chambers, large earthenware jars and cists, which though not imposing in size as the pyramids yet are so numerous and varied in type that a good deal of information of past cultures from the prehistoric and the Vedic ages to comparatively recent times can be garnered from them by a diligent search. Even in the existing incomplete data there are pointers of cultural contacts between India and the far-flung regions of the Middle East and the Far East during prehistoric epochs.

The help that anthropology and archaeology gives in broadening and liberalising our outlook on the world has been appreciated in all well-conceived educational schemes (*e.g.* the Wardha Scheme). Anthropology can do a great deal in India to remove communal friction arising from mutual ignorance of the other man's cultural background.

Psychology

Language and Education

B. KUPPUSWAMY

THOUGH while some students are taught in Kannada and some in English at the High School stage, the medium of instruction at the college level is only English at Mysore. An attempt was made to study the relative differences between the two sets of students on the basis of their performance in the several subjects taught in the college.

Among the students in the Senior Intermediate class in the years 1942 and 1943 it was found that 335 has studied their subjects in the High school through English and 252 through Kannada. Their marks in the promotional examination in English, Kannada, and all the science and arts subjects were compared. The averages were computed and the significance of the difference between the averages was studied. In English and in Economics the English group was superior to the Kannada group. But in the other nine subjects: Kannada, Mathematics, Chemistry, Physics, History, Logic, Zoology, Botany and Geology, the difference is negligible.

Barring the two subjects, English and Economics, we find that the continuation of English medium has not been a source of advantage to the English medium group nor the change from Kannada to English a source of handicap for the Kannada medium students. The performance of the two groups in the college examinations is about the same though the medium of instruction was changed with respect to some.

This investigation clearly brings out the fact that there is a confusion in the minds of people concerning the 'knowledge of a language' and 'the language as a medium of instruction'. Our results con-

clusively show that though some students learned all their subjects in their mother tongue in High schools, yet their knowledge in English language was enough to follow the lectures in the college classes in English and answer their papers in the English language just as well as those who were taught their subjects in English in the High school. In other words, the knowledge of English is not lowered when the medium of instruction was the mother tongue, so long as English is taught as a language subject.

As Ryburn remarks no child can grow up to be a good and useful citizen unless he has been properly educated in the use of his mother tongue. Clear thinking, clear expression, sincerity of thought and feeling, fullness of emotional and creative life can be cultivated best through the mother tongue.

The aim of the language teacher in the basic school should be to secure for the pupil a mastery over the ordinary language in daily use.

Recent work in Europe and America has shown that the text-books in the first few years of schooling should be very carefully planned.

There is a vast gap between the literary side and the spoken side of the modern Indian languages. The textbooks attempt to introduce the child to the literary language. But to the vast majority of our children the literary language is almost a 'foreign' language and hence the slow progress of elementary education. This problem can be solved only by preparing 'basic word lists' in each language and helping the child to master this limited vocabulary before he goes on to the literature proper. Another important aspect is a planned way of introducing new words. Books must be prepared by applying all the known principles of language learning.

Should every Indian know his mother tongue, the national language, Hindustani, and the international language, English? Further what is the meaning of learning a language? Does it mean learning to read and write in that language? Should the medium of instruction be the 'provincial language' or the mother tongue?

If the provincial language is different from the mother tongue the child automatically picks up both the languages. In the interests of economy to the child's energies as well as to the provincial educational budget it is better that the child learns in the basic school in the provincial language.

When the provincial language is not Hindustani there is no need for the child necessarily to pick up a second language. After all the bulk of the people don't move out of their province. For inter-provincial contact learning how to speak and understand the national language is quite enough.

The international language, English, is only for the few who are destined to become leaders of the community. The microscopic minority who proceed to the University should know it. The rest do not need it.

But this should not mean that any individual is prevented from learning additional languages if he wants to. Language institutes should be started in each district or even *taluk* where courses are so designed that a man may pick up in a very short time mere speaking or reading and writing as well, of the language of the neighbouring province, or the national language or the international language.

Geology and Geography

India's Position with Regard to Coal Resources

N. N. CHATTERJEE

IN his Presidential Address before the above section Prof. N. N. Chatterjee reviewing India's position with regard to her coal resources suggested a more detailed survey and prospecting work to be undertaken by the Geological Survey of India, the provincial survey departments and the Indian States and that provision for adequate staff should be made accordingly.

Referring to the high sulphur in the tertiary coals of India, Prof. Chatterjee, elaborated schemes for the desulphurisation processes, thereby making available to us these low grade coals and utilising them in an efficient manner.

The problems of coal conservation included maximum extraction and proper utilisation of coal. Regarding maximum extraction he pressed for the

introduction of vertical rotation of working and compulsory and complete stowing process in the coalfields whenever such measures would be found necessary.

The partial grading of a seam as allowed at present by the Indian Coal Grading Board should be totally and immediately stopped as such partial grading led often to extensive fires and collapses with permanent loss of valuable coal properties. Assistance should be given to those who wanted to mine coal by stowing process. It has been suggested that in order to meet the demand cess should be levied on the Coal Industry as well as on the whole population of the country on account of the fact that coal is of enormous national importance and that the industrial expansion is intimately connected with the major interests of the (*whole*) people.

Prof. Chatterjee laid great stress on the subject of proper utilisation of the different grades of coal for specific purposes. This step according to him would go to complete the process of conservation of India's coal for the likely expanding needs of the future. Of the many instances of misuse of coal in India he mentioned about the Railway Board and suggested that the Railway Board should introduce pulverised coal firing in their locomotive boilers and in this way they could profitably utilise the inferior grade non-caking coals and release a great amount of high grade caking and non-caking coals for other more important uses. He also suggested that instead of mine sampling car-sampling during despatch should be universally adopted and that sale of coal should be made by contracts on specification of analysis with an arrangement of penalty and premium. Referring to the schemes of Nationalisation and Rationalisation he strongly recommended that there should be more State control and intervention for the maximum conservation of India's limited resources of coal by process of widespread stowing and proper utilisation and suggested that the mal-practices should be stopped by strict legislation so that the coal industry might be placed on sound footing for its successful development and expansion.

The available coal resources is estimated as 10,000 million tons and calculating the probable life of the reserves Prof. Chatterjee showed that the high grade caking coals have only very short lease of life (less than 50 years) if the present wasteful methods of extraction and use is continued and thus emphasised the necessity for conservation and the urgency in the matter.

For the successful functioning of the schemes of improvement in the Coal Industry India should have a *National Mineral Policy* and that there should be a central organisation like the *Natinal Research Council* for advice and guidance. For such economic planning and for all practical purposes India should be considered as a single unit devoid of provincial barriers. Mineral deposits and their development should therefore remain the subject of the Central Government and not of the different provincial Governments.

Prof. Chatterjee concluded his Address by mentioning about the serious lack of encouragement on the part of the authorities in the matter of teaching of geology.

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SOME CONSTITUTIONAL HINDRANCES TO DEVELOPMENT OF INDIA'S NATURAL RESOURCES

THE regime of President Roosevelt who passed away suddenly is a memorable land-mark not only in the history of the U. S. A., but also of the whole world. Posterity will remember him not only for his able leadership during the present world conflagration, but also for his peacetime activities, for the drive and initiative which he brought to bear on the otherwise dry routine of administration. When he took charge of the Federal Government in 1933, the U. S. A. had been for years in the throes of a terrible economic depression the memory of which has not yet completely faded. The historian Beards describe the depression in the following graphic words:

"In the autumn of 1929, just as the country seemed safe and sound on the 'high plateau of permanent prosperity', except for farmers, the business boom attributed to Republican statecraft burst with a resounding crash. The prime stocks of the leading corporations fell nearly forty points on the average in a single day, October 29, when more than 16,000,000 shares were dumped on the market at the New York Stock Exchange. This panic was followed by the explosion of banks, railway companies, and private concerns, by increasing woes among farmers already in straits, by the closing of factories, shops, and offices, and by a steep decline in the opportunities of employment for artists, writers, musicians, architects, engineers, playwrights, and teachers indeed the whole white-collar class –from New York to California. In the opening months of 1933, it was estimated, 12,000,000 men and women were out of work. Ruin and hunger, if not starvation, haunted not only the shacks of tenants and sharecroppers on the land, not only the back streets inhabited by industrial and professional classes, but also the grand avenues of great cities."

President Hoover, a republican who was then occupying the White House, wrestled in vain with the situation in his own way, and in the Presidential Election of 1932, he had to make way for the democratic candidate, Franklin D. Roosevelt who at once took energetic measures now known as the 'New Deal' to cope with the situation. This measure substituted Federal interference and initiative in place of *laissez faire* almost in every walk of life and had been the target of continuous attacks by the Republicans. But whatever opinions might be held about the measure, it is admitted that it dealt effectively with "Unemployment".

One of New Deal measures was the undertaking by the Federal State of huge developmental schemes for providing employment; these works were generally put in charge of relevant Federal Departments *e.g.* the Bureau of Reclamation which planned huge projects—building of dams, excavation of canals, and construction of hydro-electric stations. In 1938, work was in progress in 32 projects in 12 different States. It was during Roosevelt's regime that the Boulder Dam, the Grand Coulee Dam and many others too numerous to mention were constructed, and as a direct consequence of these measures America's productive capacity was enormously increased. It was during this period (1934) that President Roosevelt tried a new experiment in administration by creating the Tennessee Valley Authority to deal with the Tennessee River. It may be mentioned here that though the TVA Act was actually piloted through the Congress by Senator Norris during the regime of Roosevelt's predecessor, the measure was vetoed by the latter as being antagonistic to the American tradition of interference with private enterprise.

It is well-known that it was only President Roosevelt's forceful backing which was responsible for the quick execution of these constructive measures. In the U. S. A., there is a good deal of ambiguity in the constitutional position regarding the prerogatives of the States and the Federal Government, and legally many measures could not have been under-

taken without the concurrence of the States concerned. To take one example, in the Boulder Dam project, the river to be harnessed *viz.*, the Colorado River or its tributaries pass through the States of Utah, Wyoming, Arizona, New Mexico, Colorado, Nevada and California. Six of the States ratified the project drawn up by the Bureau of Reclamation, but the State of Arizona where the dam site is situated took a hostile attitude and never formally ratified the scheme.* Probably under a less resolute President than Roosevelt many of the projects of his State departments would have remained dead letters in the face of such strong opposition.

We have already indicated how in the case of the TVA Roosevelt circumvented the constitutional difficulty by enjoining the Authority to take such measures as will make the river "navigable with 9 feet of draft". It is now known that 'Navigation' was only the thin end of the wedge, and the Authority carried out the fullest measures of multi-purpose development, *viz.*, flood prevention, soil conservation, navigation, and power generation, some of which undoubtedly, according to the constitution, were prerogatives of the States. The TVA projects have been frequently challenged in the Supreme Court by interested parties, mostly capitalists owning private electrical undertakings. We quote in this connection an interesting passage from Barrows' 'Water Power Engineering' (1943). The case is not connected with TVA projects, but nevertheless, it deals with a pertinent legal question :

"The decision of the U. S. Supreme Court in the New River case (85 L. Ed. 201) was of importance in this respect, for this case involved the scope of the Federal Commerce power in relation to the requirements of a Federal license upon New River, in the States of Virginia and West Virginia. The district and circuit courts had both held that New River was not navigable and that the United States could not enjoin the respondent from constructing and putting into operation a hydro-electric dam on the river just above Radford, Va. The U. S. Supreme Court, under date of December 16, 1940, found that New River was navigable, and further more affirmed that the constitutional power of the United States over its water is not limited to control for navigation. In this respect the Court stated :- In truth the authority of the United States is the regulation of commerce on its waters. Navigability, in the sense just stated, is but a part of this whole. Flood protection, watershed development, recovery of the cost of improvements through utilization of power are likewise parts of commerce control . . . the respondent cannot, by seeking to use a navigable waterway for power generation alone, avoid the authority of the government over the stream. That authority is as broad as the needs of commerce. Water power development from dams in navigable streams is from the public's standpoint a by-product of the general use of the rivers for commerce. To this general power, the respondent must submit its single purpose of electrical production. . . . The point is that navigable waters are subject to national planning and control in the broad regulation of commerce granted by the Federal Government. The license conditions to which objection is made have an obvious relationship to the exercise of the commerce power."

* It is said that Arizona actually mobilized its army to stop the Boulder Dam project being carried out.

Since the success of the American experiment, the idea of total development of river valleys has caught the imagination of the people and government of all countries. In the article by Mr K. Ray, published elsewhere in this issue, a description has been given of an attempt to develop the Murray River Valley in the Australian Commonwealth. One point will at once strike the reader ; the rate of progress in Australia has been tantalizingly slow owing to the fact that four parties, *viz.* the States of Victoria, New South Wales, South Australia and the Federal Government had to agree before any measure could be undertaken. For example, though schemes for water power development have been prepared since 1924, no active measures appear to have been taken for twenty years. Australia has not produced a Roosevelt courageous enough to cut through the smothering red tapes of Constitution !

The importance of undertaking full scale development of river valleys has now been recognized in this country. Dr B. R. Ambedkar, the Hon'ble Member for Labour, presiding over the conference of representatives of the Central, Bengal and Bihar Governments, held in January, 1945 (*vide* SCIENCE AND CULTURE, February, 1945, p. 333), revealed the Government's intention to create the Damodar Valley Authority. In that connection he remarked :

"The Government of India have very much in their mind the Tennessee Valley scheme operating in the United States of America. They are studying the scheme and feel that something along that line can be done in India if the Provinces offer their co-operation and agree to override the provincial barrier which has held up so much of their progress and their prosperity.

"The Damodar river is the first project along this line. The authority which will be in charge of this project after it is completed, will be more or less modelled, as far as it may be possible, on the *Tennessee Valley Authority*. It will be a co-operative undertaking in which the Centre and the Provinces of Bihar and Bengal will be partners. The Government of India are anxious to give shape, form and life to the project, and are keen that no time should be lost in doing so.

"The Government of India feel that they cannot proceed further in the matter unless certain preliminaries are explored. The first such preliminary is the site of the dam. Obviously it cannot be decided in accordance with the wishes of Bengal. Equally, it cannot be decided in accordance with the wishes of Bihar alone. And even if the two Provinces agree upon a site it could not be finalized without the advice of experts. There are other aspects which have also to be gone into."

We learn from a recent press report that the Government have decided to set up a Central Waterways, Irrigation and Navigation Commission. The Commission will advise the Central, Provincial and State Governments on waterways, irrigation and navigation problems, on principles governing water rights, inter-provincial disputes, and on appropriate basis of agreement between the parties in dispute. But the Commission is no substitute for the Authority. Besides, past experience of the working of such commissions does not encourage us to entertain any optimistic view. We think that it would have been

a better policy to create a new department like the Bureau of Reclamation in the U. S. A.

We have not heard anything further about the appointment of the D.V.A., and according to a reliable source of information, the Central Government finds that probably they have not got the constitutional power to appoint such a new type of administrative machinery as the D.V.A.

According to List-II of the Government of India Act of 1935 (*vide* C. L. Anand, p. 559), the provincial legislative list (defining the functions of provincial governments) includes (9) water, that is to say water supplies, irrigation and canals, drainage and embankments, water storage and water power, (20) inland waterways and traffic thereon, while List III, containing the entries under the concurrent legislative list, includes (31) electricity, (32) shipping and navigation on inland waterways as regards mechanically propelled vessels.

We are not lawyers, but it is obvious from these passages that the D.V.A. referred to by the Hon'ble Member for Labour cannot be created unless the Central Government and the two Governments of Bengal and Bihar agree to do so. For the two Provincial Governments it means surrender of some power with which they have been invested under the Government of India Act of 1935, and one would be too optimistic to think that the two Provincial Governments would willingly surrender such power.

On the otherhand, we have not the slightest doubt that the course suggested by the Hon'ble Member for Labour is the right one, for the existing departments of the Provincial Governments have neither the personnel, equipment, nor the organization to frame comprehensive schemes and to tackle the multipurpose development of river valleys, and even if they create such an organization, it is doubtful whether two Governments can agree, quickly enough for the ensurance of the success of the scheme, upon a common line of action. This is true not only of the Damodar Valley, but for almost every river-valley which needs a similar treatment, for there is scarcely a single river valley which is confined within the limits of one single province or one single Indian State. By making *'Inland Waterways'* a provincial subject, the Government of India Act of 1935 has created a constitutional hindrance to development of India's natural resources, and we can scarcely expect any Rooseveltian lead from the Government of India as at present constituted.

SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—IV.

THIS article is the last of a series written with a view to clearing our ideas as to how scientific education and research can be utilized for purposes of national welfare. With this object in view we have in the first two articles given an account of how such problems are being considered in other countries like Great Britain and the U. S. A. In the last article we have made a survey of the facilities for advanced teaching and research in science available in this country, and of the suggestions which have been made for improving them. We started with the dictum that academic and industrial research are interdependent and complementary, from which we concluded that applied research *i.e.* application of science to problems of human welfare will flourish best under conditions under which fundamental research are found to be promoted. We have now, in conclusion, to consider the conditions favourable to the promotion of fundamental research in this country.

Planning of Fundamental Research

If we accept the view that application of science is essential in all schemes of planning for national welfare we have also to accept the corollary that fundamental research is a public need and a public responsibility.

The industries of our country are based upon fundamental discoveries of past generations; that some of them are successful depends upon a combination of favourable circumstances *viz.*, availability of raw materials, and of a large though poor consumer population. These industries have not been able to raise appreciably the standard of living of our people. For this purpose a much greater application of science to industry is necessary and for it two conditions are essential, namely (*a*) to establish conditions favourable for growth of fundamental research and (*b*) to diminish the time lag between the making of significant discoveries and their practical application to industry, agriculture, and medicine. The first is research and the second is development; both are essential and in both we have not so far achieved any large measure of success. When speaking of the needs of one, we do not desire to depreciate the other. Both Government and industry must recognize the essential importance of the former and also provide facilities for the latter. It will not be right to blame the scientist if he cannot at one and the same time make new discoveries and also develop

them to such a stage that the 'practical' industrialist and the financier can at once realize their applicability. Both the scientist and the industrialist must broaden their outlooks so that by mutual co-operation it may be possible to develop the technique of the pilot stage of production. A. R. Olpin states in a recent discussion in the U. S. A. that 'during the war many physicists are learning for the first time that there is as much thrill and satisfaction in applying physical truths as in discovering them.' Some of us in this country who have obtained their initiation in applied research during the present war have had similar experiences. We shall welcome similar expressions of change of outlook from some of our industrialists on the place of pure research in industry.

We have now to consider how fundamental research in this country should be financed and who should undertake such research. We have seen that in the U. S. A. training and research are supported (*i*) from funds of foundations and endowments, (*ii*) by industry, and (*iii*) by Government. In our country we obtain very little support from industry ; a part of the examination fees received by some universities are utilized for this purpose, a not very desirable expedient. (*i*) represents usually the accumulated savings of the country. Some institutions for the advancement of science were founded in this way, *e.g.* the Indian Association for the Advancement of Science by Mahendralal Sircar, the Indian Institute of Science, Bangalore by Jamshedjee Tata, and the Bose Research Institute by Jagadish Chandra Bose. Besides two Bengali lawyers Taraknath Palit and Rashbehary Ghose gave away their life's savings to the Calcutta University for the endowment of a number research professorships in pure and applied sciences. Since then, as the intimate relation of applied research to industry began to be realized, the tendency has been to endow applied science. The industrial magnates have not yet discovered that 'applied science cannot live on the fundamental discoveries of past generation, and that unless fresh discoveries are made it dies of inanition.' There has been during the past few years a great accumulation of profits from war industries ; but as yet no part of it is being set apart for the endowment of pure research. It remains to be seen whether the recommendations of the Industrial Planning Research Committee will include provisions for the support of pure research.

In the past the Central Government have provided funds for support of applied researches in medicine and agriculture. Besides a number of surveys are maintained by the Government in botany, geology, geodesy, meteorology, and zoology. Though these surveys are directed towards primarily practical ends, many first rate scientific publications have come out from these surveys. The several retrenchments to which these surveys have been subjected, on the recommendations of Committees presided over by such eminent business men like Lord Inchape and Sir R. N. Mookherji, have resulted in a considerable curtailment of their present usefulness. There is a great deal to be said in favour of A. V. Hill's suggestion (V) that the research organizations of the Central Government at present attached to different departments, like Education, Health and Lands, Industry, Labour, Post and Telegraphs should be put under a Central Organization for Scientific Research and placed in charge of the Member for Planning and Development. 'One great objection to the organization of research under a number of separate authorities, quite apart from lack of co-operation and a common policy resulting from it, is that financial and other support of research is often patchy and inadequate. The present sorry positions of the Botanical and Zoological Surveys and of Fishery Research is a good example how important scientific activities can be starved under a Department in which at some moment there was a failure of interest in them. The decision not to complete the 1941 census of India could never have been taken if the consequences had been properly thought out. . . . Under a central organization for research the different subjects could hope to be treated with the same degree of uniform encouragement according to their needs'.

In many reports we find the suggestion that fundamental researches should mainly be undertaken in the universities. It may be true that in the past century many fundamental discoveries have been made in university laboratories ; even then the Royal Institution during the time of Davy and Faraday has been responsible for many of them. In recent years the Kaiser Wilhelm Institutes in Germany, the Research Laboratories maintained by Rockefeller, Carnegie and other well known foundations, and other laboratories maintained by big industries in America like the G. E. C., R. C. A., Bell Telephone Laboratories are responsible for many such discoveries. Under modern conditions even in this country it will not be wise to tie up fundamental research with the universities. They are primarily places for advanced training in science and in methods of scientific research ; besides they undertake also researches in pure and applied sciences. It is desirable that universities should receive adequate grants for equipment, maintenance of laboratories, for the establishment of new schools of research, and also for the maintenance of a number of research scholars and fellows. There are, however, certain drawbacks attached to university research, when co-operation of specialists from several sciences are required for the purpose of forming research units. Departmentalism of science arising from the requirements of teaching

does not encourage such interdepartmental co-operation.

Some thing can be said in favour of starting independent research institutes in which research is directed towards the realization of a not too closely defined aim ; in which provision is made for research in pure and applied sciences. In such an institute specialists from several sciences can be recruited, who, while free to devote themselves to investigations pertaining to their particular sciences, can also co-operate in investigations where team work is necessary. Such institutions can be maintained from endowments or Government grants or from both, supplemented by grants from organizations supporting research. Possession of endowments enable such institutions to undertake some fundamental research, whose utility may not be immediately discernible, while a certain amount of ballast is provided by the acceptance of grants for specific applied research problems. Such institutions should be in touch with their local universities and should also undertake the training in research of successive generations of young workers.

Fundamental research can, therefore, be undertaken in different institutions, *e.g.* (*i*) in universities and other teaching institutions of university status, (*ii*) in Research Stations maintained by grants from Imperial Research Councils for Agriculture and Animal Husbandry and under similar Councils for Medical, Scientific and Industrial Research, (*iii*) in industrial research laboratories, when industry has become sufficiently scientific minded to value and encourage pure research, and (*iv*) in research institutions. At present in many Government scientific departments some confusion exists between the relative importance of research, development and extension, and it happens sometimes that research minded young officers are discouraged by their official heads from undertaking any research work. Probably the suggestion of A. V. Hill of bringing 'research into a single organization, and leaving the departments to make their own arrangements for applying the results to practical problems they have to face' may obviate these difficulties.

All such proposals for extension of research will involve grants from public funds on scales much larger than has yet been contemplated in this country. Such grants should preferably be given in the form of block grants extending over a number of years, and distributed through some committee in which non-official scientists are strongly represented.

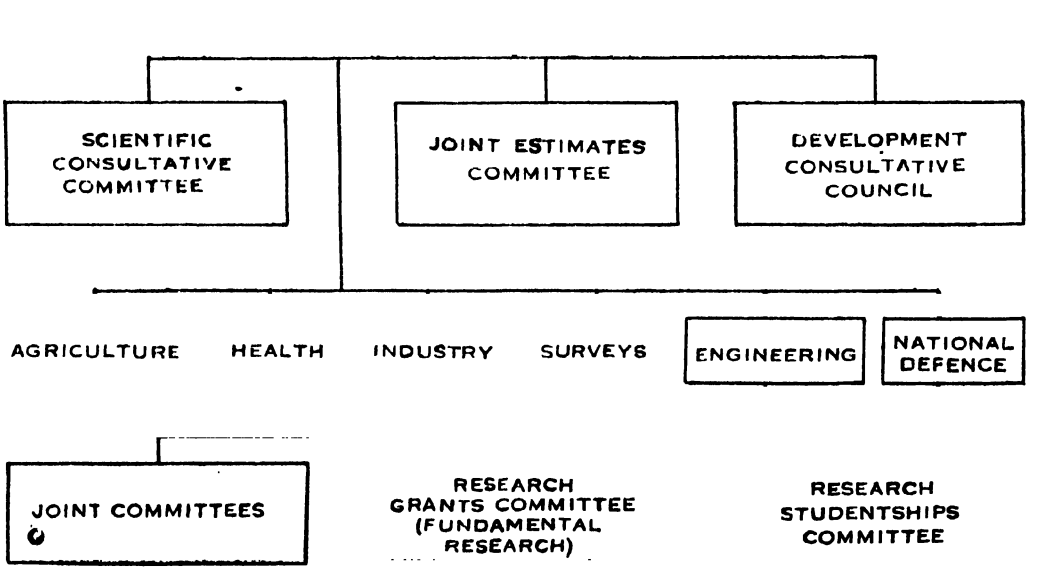
Organization of Research

We have seen in a previous article how State supported research is organized in the United Kingdom. Such research is controlled through the agency of three Research Councils for Agriculture, Industry and Medicine, all in charge of a single Minister, the Lord President of the Council. The executive heads of these Councils are the secretaries who have all been very distinguished scientists. The Councils are also the governing bodies and are composed mainly of distinguished scientists, professional men and industralists with scientific interests and are presided over by non-official Chairmen. The appointments to these Research Councils are made by the Lord President, and the concurrence of the President of the Royal Society has to be obtained in each case.

In the U. S. A., the National Research Council is described "as a co-operative organization of scientific men of America ; its members include not only scientists and technical men but also business men interested in engineering and industry. Membership of the Council is composed largely of representatives nominated by 85 scientific societies and include representatives of some research organizations, of Government Scientific Bureaus and a limited number of members at large. The total number is 220 in all. About one third of its members are appointed by the President of the United States after being recommended by the National Academy and from the various departments of the Government, such as War, Navy and others. All the rest receive their formal appointments by the President of the National Academy of Sciences." The constitution of the N. R. C. is entirely democratic ; on the other hand, its function is only advisory and for ensuring co-ordination. It has no executive authority for the disbursement of public funds for support of research. A new body called the Office of Scientific Research and Development has been created by executive order for this purpose.

Turning to the question of organization of research in this country, two schemes are before us, (*i*) one formulated by A. V. Hill in his report (V) and (*ii*) the other sponsored by the National Institute of Sciences for India (see Science and Culture, February, 1944). Hill's recommendations are extensions and modifications of the British plan to suit what Hill considers to be the present Indian conditions. The proposals are for the creation of a Central Organization for Scientific Research under the Member for Planning and Development, under which six Research Boards will be constituted. The members of each Board will be mainly eminent and experienced scientists with a certain number of professional men in the respective fields, whose number will not exceed those of the scientists. There is a half hearted suggestion that perhaps the National Institute of Sciences may be allowed to nominate some of the members of the Board Each Board will have a certain number of ex-officio members representing the Development Departments. Each Board

will have as Chairman a non-official, either a distinguished scientist or a professional man in the field concerned. There will be a Director of Research associated with each Board, who will be its secretary and principal administrative officer. The Directors of these Boards will be responsible, under advice from their respective Boards and under the Member for Planning, for directing, organizing, initiating and coordinating research on a national scale in their respective subjects. Each Board will have the power to allocate grants for specific researches in its own fields, to be carried out by agreement in any institution in India. There will be a Joint Research Committee of all the Boards to award grants to university and other research laboratories throughout India for the encouragement of fundamental scientific research in general. When a University Grants Committee is set up, these general grants will be given in consultation with it. Also a Research Studentship Committee will be set up jointly by different Boards, to consider applications for Research Studentships. There is provision for preparation of joint estimates for presentation, through the Member in charge, to the Finance Department for approval and sanction, after which the Boards will be free to spend. These six Boards will replace the existing three Councils of Research. There will be also a Scientific Consultative Committee consisting of six Directors and six distinguished scientists to advise the Member in charge on general policy in relation to research.



A plan for the organization of scientific research and development in India.

Hill's scheme is a well thought out one and, as said before, it is based upon British precedents, but with certain essential differences. The appointing authority for the members of the several Boards will be the Member in Charge who, unlike his British colleague, is not under the control of the Legislature, and therefore, not removable by adverse vote ; his appointment and removal will be with the Governor General. Our past experiences do not justify the expectation that all decisions of the Governor General will be taken purely with the view of safeguarding Indian national interests. Further the Member in charge, when considering names for appointment to the different Boards, will not have the benefit of advice from any non-official scientific body as provided in the British case. He will have to depend primarily on the advice tendered by the Directors of the different Boards, and there may be a tendency on the part of some of the Directors to recommend 'yes men' for such nominations. Also the Boards so constituted will not be responsible to any representative scientific council for their activities. The scheme sponsored by the National Institute of Sciences contemplate the formation of a National Research Council, consisting of scientific and technical experts, not exceeding sixty in number, the majority of whom shall be elected by non-official scientific organizations including universities and other institutions of university status, the remainder being nominated by the Central Government from amongst their scientific and technical experts. This Council will formulate plans and watch over the main lines of research and technical development, advise Government on a common policy, distribute grants allocated to them by the Central Government for promoting approved researches, for the mainten-

ance of selected research scholars, for scientific publications and for other purposes. This Council will, in consultation with certain non-official scientific organizations, constitute Research Boards, four in number for the present. The functions of these Research Boards will be generally similar to those proposed in Hill's report, except that no provision has been made on matters of appointing Directors of Research associated with such Board and of the powers to be exercised by those Directors. The present scheme require to be further elucidated, both as regards the composition of the Research Boards and the nature of the control to be exercised by them over the Research Stations under the Central Government. The scheme has the primary merit of interposing between the source of funds for the support of research, viz., the Government together with the Legislature, and the recepients of such support an independent body of scientists, with a necessary amount of representation from other interested bodies. The authority which such a Council will exercise depend on the attainments of the scientists elected or nominated to it. As Dr F. B. Jewett, President of the National Academy of Sciences, U. S. A., truly remarks, "If you want to get a thing done, don't give people police authority to do it—make them so distinguished that nobody dares run counter to their advice."

RIVER MURRAY COMMISSION IN AUSTRALIA

KAMALESH RAY

THE proposal of harnessing the Damodar River as a planned unit has presented certain difficulties on the question of provincial rights and responsibilities, since the river flows through two provinces of Bihar and Bengal. The river and other natural resources of a country, however, do not obey the political boundaries, and if we have to develop fully all that the river is capable of giving us, the governments concerned must have to invent the necessary administrative machinery to deal adequately with the problem, and, if necessary, circumvent the restrictions imposed by a defective Act of the Government (1935 Act). Such has been the story of all the rivers and river basins of the world, *e.g.* the Danube in Central Europe which flows through a number of sovereign countries, the Tennessee in the U. S. A. which flows through seven States of the Union, (for detail, see SCIENCE AND CULTURE, April, 1944), and the River Murray in Australia. The last river forms the subject of our present study and criticism.

THE RIVER AND THE PROBLEMS

The River Murray has a total length of 1,700 miles, with drainage basin 2,50,000 sq. miles. It forms the boundary between New South Wales and Victoria States for about 1,200 miles and then flows through South Australia for another 500 miles before it enters the Lake Alexandriana and communicates with the sea. The river rises at the Australian Alps at an elevation above 7,000 feet and drops to the plain in course of its first two hundred miles and then traverses a great length over flat country with an average slope of 3 inches to a mile. It has a large number of tributaries, the most notable of which are the Darling and the Murrumbidgee rivers.

The problems associated with the Murray River in Australia have nothing striking in particular and present the usual story of the people taking trouble to move the Government in devising ways and means

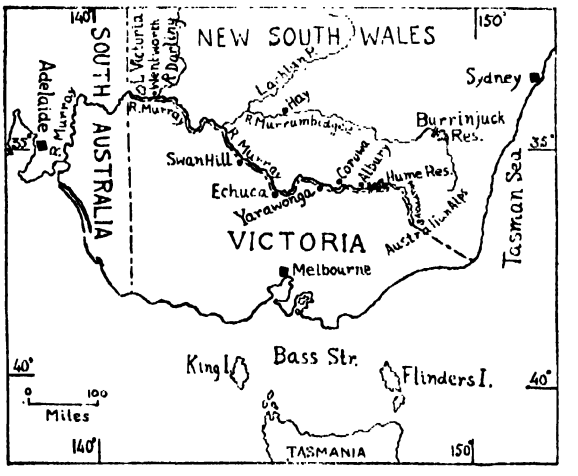


FIG. 1. Course of the Murray River.

to develop the river system for the benefit of the country.

The early problems were restricted to navigation and irrigation, and the attention to these problems was drawn as early as the middle of the nineteenth century. But as the river flows through the three States, *viz.*, New South Wales, Victoria and South Australia, the difficulty of reaching agreement on the question of utilizing the river to the advantage of all raised problems of the rights of the three States to the river. The differences of outlook of the various authorities concerned undoubtedly prejudiced for many years any serious attempts to arrive at a satisfactory agreement.

Early Investigations

Primary investigations, however, were made by Royal Commissions to enquire into the utilization of the waters of River Murray by the Government of New South Wales in 1844, by Government of Victoria in 1886 and by the Government of South Australia in 1887.

In 1902, the Murray River Main Canal League held a conference at Corowa in April 2, 3, and 4 and invited the Prime Minister of the Australian Commonwealth, the Premiers of the three States, and many other representatives of various districts and associations. The Murray River League passed the following resolutions:

(1) The Governments of the Commonwealth and States concerned be urged to co-operate in preparing and carrying out a comprehensive scheme for the utilization of the waters of the River Murray which while improving the navigability of the river would also provide for the imperative needs for the residents on both banks in the conservation and distribution of its waters.

(2) That the States of New South Wales, Victoria and South Australia empower the Federal Government to provide definite storage reservoirs on the Upper Murray and a weir at Bungwannah, such works to be national.

(3) That public bodies interested be approached by their respective Governments and requested to complete their distributing works concurrently with the head works.

(4) That all natural waters not already appropriated under legal sanction shall be declared public waters and made subject to a suitable system of law applicable to the whole continent Commonwealth and States to consider legislation to provide for regulation and disposal to secure fullest possible use for the whole people.

In his reply to the conference of the River League the Prime Minister, Mr Edmund Barton made it clear that the Commonwealth has sympathy and support for the movement, but would not like to arrogate to itself any power or to interference with respective State rights; and that enquiry among the States should be made about the recommendations of the League. He further suggested that to remove any political difficulties standing in the way of consummation of the scheme, the proper procedure would be to place the whole question in the hands of an authority which would be of an impartial character.

A Royal Commission was again instituted on 13th May, 1902 "to make a diligent and full enquiry concerning the conservation and distribution of the waters of the River Murray and its tributaries for the purpose of irrigation, navigation and water supply". The Commission gave the following recommendations:—

(1) The division of waters of the Murray basin between the three States.

(2) The construction of storages in the Upper Murray, at Lake Victoria, and weirs at the Murray mouth.

(3) Appointment of a permanent River Murray Commission.

(4) First instalment of a scheme of locks.

(5) Legislation to vest the ownership of all natural waters in the Crown.

(6) Diversion scheme to proceed concurrently with the construction of the dam or the storage reservoir.

The Royal Commission remarked on the creation of a permanent River Commission as follows: "The control of Navigation being in the Commonwealth, and of Irrigation and Conservation in the States, it is necessary that their administration should be kept apart. Whilst, however, Commonwealth authority and control of State rights should be distinct, it is important that there should be proper concert between them. This object would be secured by the appointment of a Permanent Commission, representative of New South Wales, Victoria, and South Australia, to administer and control diversions, and to construct and control those works of irrigation and conservation in which more States than one are concerned, with power to consult with the Federal Government, and to conclude agreements with it, on all such matters affecting rivers as are subject to Commonwealth jurisdiction. The realization of this proposal would demand concurrent legislation on the part of the States, with confirmatory action by the parliament of the Commonwealth.

River Murray Waters Act of 1915 and Creation of River Murray Commission

By a resolution at a conference of the Premiers of the three States held in Melbourne on 23rd January 1911, three engineers were instructed to present a report and recommendations which would be essential or conducive to a settlement by agreement between the three States on the question of River Murray and its tributaries.

The engineers sent their report and recommendations on 24th July 1913. Their recommendations chiefly concentrated upon Upper Murray storage of nearly a million acre feet to start with, and contained suggestions for building more storage dams on the tributaries as the main work progressed. The building of navigation locks and planning of diversion work for water distribution were also suggested. On the administrative direction, the Conference of Engineers suggested agreements between the three States.

The agreement was eventually entered into on 0th September 1914 to carry into effect the resolutions concerning to the economical use of the waters of the River Murray and its tributaries for irrigation and navigation and the reconciliation of the interests of the Commonwealth and the riparian States.

The agreements were ratified by the Act of Parliament—the River Murray Waters Act, 1915. Similar legislation was passed in the three States simultaneously, and it came into force on 31st January 1917.

The River Murray Commission was also appointed at this stage to give effect to the agreements and Act. The Commission consisted of four Commissioners, one from Commonwealth (he is the President) and one from each of the three States.

The River Commission, however, is not a body corporate and has no power to contract and carry out works or to acquire land. The Commission, however, may employ under its sole control officers and servants and may remove or dismiss them. It may also arrange with a contracting government for the performance of work or services by officers of that government, and the services of any such employees may be used partly by the Commission and partly by the contracting governments. Besides, the Commission (*a*) carries on an affective and uniform system of stream gauging on main river, tributaries and diversion branches natural or artificial, (*b*) deals with matters of finance, collecting from the three States and the Commonwealth their shares of the estimated expenditure for each year and remitting to the States the funds required for the works to be carried out, (*c*) approves of the general schemes of works submitted by the States, (*d*) orders, directs and supervises the work and watches the progress, (*e*) collects tolls and apportions same to the States, (*f*) may declare quantities and times for deliveries of water and the means of varification of all deliveries of water provided for in the Agreement, (*g*) submits annual report and balance-sheet to contracting governments.

The State governments are responsible to maintain the works constructed by them including snagging and dredging in the vicinity of the works.

Funds and Progress of Work

The original cost of construction was apportioned thus:

Commonwealth	£1,000,000
New South Wales ..	£1,221,000
Victoria	£1,221,000
South Australia	£1,221,000
Total ..	£4,663,000

Under a later agreement the amount was increased to a sum not exceeding 12 million pounds, to be borne in equal shares by the contracting governments.

By the close of 1944, the following works have been completed (excepting certain minor details):

(*a*) Upper Murray storage of capacity 1,250,000 acre ft. at Hume Dam, with a provision to increase the capacity to 2 million acre ft.

(*b*) Provision of storage at Lake Victoria.

(*c*) Construction of 5 barrages.

(*d*) Construction of 14 weirs with locks.

(*e*) Construction of 2 weirs on River Murrum bidgee.

The total expenses incurred so far have been estimated at £11,896,091, or nearly 16 crores of rupees.

It has now also been proposed that after the war, when labour and materials would be easily available, the Hume Reservoir should be increased in storage capacity from 1¼ million acre ft. to 2 million acre ft. by raising the dam height.

Among other post-war policies, one is that the water supply authorities would be made responsible to educate farms in scientific agricultural practices. Incidentally, this reminds us of the demonstration farms of the Tennessee Valley Authority in the U. S. A.

Question of Hydro-Electric Power Development

The question of developing hydro-electric power from the Murray waters, particularly at the Hume Dam, has been in consideration since 1924, following upon a conference. The question was again discussed in 1930, but no conclusive action was taken. At the minister's conference in January 1944, it was again raised by the Victorian representatives when the following resolution was passed.

"That the question of the utilization of the Hume waters for purposes of generation of electricity be referred to a conference of representatives of the appropriate departments of the Commonwealth, New South Wales, Victoria and South Australia, as a continuation of discussions entered into in 1930 to determine the manner of utilization of the waters so far as generation of electricity is concerned."

Recently another conference was held of representatives of the Commonwealth and the State Electricity Undertakings to further consider the question. A report of this conference is awaited.

Regional Planning on Murray Valley as a Post-War Reconstruction Project

As the ideas are developing and progress is made, the problem of the regional development of the River Murray Valley has been raised by the Ministry of Post-War Reconstruction and also by municipalities and other bodies interested in this matter, who have formed themselves into a Murray

Valley Development League. The League held a conference on 15th and 16th August, 1944, and made the following recommendations to the Commonwealth Government:

"That this conference ask the Commonwealth Government to set up a Board of Enquiry consisting of representatives of the Commonwealth and the three States of South Australia, Victoria, and New South Wales, to report on all matters in connection with the development of the Murray Valley, in all its economic, cultural and social aspects, having regard in particular to the following subjects:

(*a*) The condition of settlement throughout the Valley.

(*b*) Any alteration in existing condition of settlement that may be desirable in order better to induce increased settlement, development and production.

(*c*) Methods for the better utilization of the lands of the Valley and the development of their potentialities by (*i*) the further development of the irrigation schemes; (*ii*) ensuring the use of the land for the purpose for which various areas are best-suited; (*iii*) encouraging the investment of capital therein; (*iv*) securing the permanent improvement of the lands by correction of soil erosion, reafforestation and pastures; (*v*) encouraging increased profitable production; (*vi*) providing for organized marketing of products; (*vii*) the establishment of appropriate industries.

(*d*) The transport facilities of the Valley and any possible improvement of an economic nature having regard to the needs of the land, industries, and particularly the marketing of products.

(*e*) Generally a plan of development in respect of the lands and the land industries over the next 50 years.

(*f*) The productive potentialities and population supporting capacity of the valley under the system of development which may be recommended.

(*g*) The provision of amenities, social and cultural, for the increased population that may accrue by the implementation of the recommendations of the Committee.

(*h*) The administrative organization necessary to give effect to the carrying out of the plan of development recommended; and that in view of its grave importance the question of restoring and maintaining the Murray Catchment area be referred to the proposed expert Committee for urgent consideration".

Realizing the importance of the unified regional planning for the Murray basin, the Commonwealth Government at the instance of the Ministry of Post-War Reconstruction has approached the State Governments of New South Wales, Victoria and South Australia with a view to setting up a Committee of Enquiry consisting of representatives from the four governments to investigate and report on the possibilities of the regional planning for the Murray Valley.

Conclusion

The preceding study of the situation* reveals that the Murray Valley problem in Australia is taking the modern shape, the trend being the acceptance of the policy of national resources development on a regional basis. The public, local authorities and the Government, Central and Provincial, have taken active interest, and some amount of constructive work has been done.

At the same time it is difficult to overlook the slow process through which the works have progressed under the usual bureaucratic methods of the Government so common in pre-War days. More than a century elapsed to consider, investigate, reconsider, report, and recommend on the problems and nothing more than irrigation and navigation has been considered for execution.

The question of developing hydro-electric power at the Hume Dam was raised in 1934, and the problem still remains to be considered, although it has been considered several times already. Resolution has been recently passed (1944) to carry on negotiation with the relevant authorities 'as a continuation of discussions entered into in 1930.'

The slowness of pace in Australia reminds us, incidentally, of the move of our Government, Central and Provincial, on the problem of the Damodar River which has been taken up on many occasions of catastrophic flood but subsequently kept down in cold storage. The Damodar problem has been considered investigated and recommended upon since 1857, and the cycle of inaction is still in progress. The proposal for the construction of dams on the river and its important tributaries, as made by expert engineers, was always before us since 1864, but no constructive work was undertaken in course of these 80 years.

In contrast with these procedures, we see the comprehensive work done by the Tennessee Valley Authority in the U. S. A. The river authority was created in 1933 by Mr Franklin D. Roosevelt almost immediately after his presidential election. The early history, however, is equally slow, lengthy and conflicting, until Roosevelt came into power and was able to elbow through all the oppositions, and cut clean through the smothering red tapes.

The TVA, being given full power to plan and execute on the river basin development, has been able, in course of its 12 years of existence, to harness about 20 million acre foot of water

* Most of the information has been freely drawn from a pamphlet on River Murray Water Act, 1915-34, printed by the Government of Bengal.

in two dozens of colossal dams it has built, to maintain 650 miles of the river for year round navigation—now carrying more than 160 million ton-miles a year, and to develop 12,000 million units of electricity annually. The TVA has also been responsible for soil conservation of the Valley, farm demonstration to teach scientific agriculture, production of fertilisers, increasing fishery five times, national defence etc. All these speedy achievements are to be ascribed to the appointment of the TVA, an autonomous organization of experts who were vested with the authority of planning and executing the Valley's economic problems in a comprehensive and unitary way. TVA is unhintered by the red tapes of bureaucratic governments, the ups and downs of party politics, or mutual jealousies of the different States.

From the comparative studies, one would feel that the old form of governmental machinery should be thoroughly changed to keep pace with the present world of speed and progress. The necessity of this change becomes imperative when one is confronted with the problem of resource development on the basis of river basin as the natural regional unit, which requires State support and necessary legislation to carry the plans into operation.

RESEARCH AND TAXATION

THE scientists and industrialists all over India will heartily welcome Hon'ble the Finance Member's significant proposal to allow for income-tax purposes expenditure on scientific research in his recent budget speech. The Hon'ble the Finance Member Sir Jeremy Raisman said:

"I am also proposing to allow for income-tax purposes expenditure on scientific research. The proposals follow generally the provisions in the U. K. Finance Act 1944, which have been described by the Chancellor of the Exchequer as 'a comprehensive attempt to relieve from taxation altogether funds devoted by industry to the support of fundamental research, to the translation of laboratory research to production and to the full-scale development of the product'. The proposals, in brief, are the allowance of current research expenditure as it is incurred, the allowance of payments to recognized research bodies and institutions and the allowance over a period of five years or over the life of the assets, if shorter, of research expenditure of a capital nature."

A Bill containing provisions for these reliefs, we understand, has been put before the house to amend the Income-tax and E. P. T. Acts.

In making this proposal, the Finance Member has closely followed the example of the U. K. Government which have made provision in the Finance Act 1944 to relieve from taxation funds devoted to the conduct of research. In his Budget speech last year, Sir John Anderson proposed relief from taxation funds devoted to research. Previously a distinction was drawn for income-tax purposes between capital and revenue expenditure on research. It was time for modifying the distinction, and the Chancellor proposed that any research expenditure of a capital nature, including expenditure on laboratory buildings, plant and machinery, should be allowed for a period of five years, or for the life of the asset, if shorter. This expenditure should be deducted from profit for income-tax purposes. This should also apply to any payment, whether for capital purposes or not, made by an industrial concern to a central research body approved by the Department of Scientific and Industrial Research.



Sir Jeremy Raisman

The Chancellor of Exchequer further proposed a special allowance of 20 per cent of the cost of new plant and machinery and suggested that, as a part of post-war policy, the absolescence allowance should be given when plant and machinery are scrapped. An annual depreciation allowance of 2 per cent, with an initial allowance of 10 per cent as an immediate instalment, was prescribed in the case of factories and buildings associated with them for welfare purposes or storage.

We understand from a report in *Nature*

(February 29, 1945) that a Bill to give effect to the proposals for the provision of relief from income-tax for industry and agriculture during the reconstruction period after the war has now been introduced in the House of Commons. The allowance provided for in the Finance Act 1944 with respect to scientific research is now to be extended to payments made after April 6, 1944. Expenditure incurred on buildings, plant and machinery for research after January 1, 1937 is also proposed to be entitled to allowance. Industrial buildings concerned with welfare, such as sports pavilions, houses for workers at mines or oil wells, agricultural buildings and works, it is stated, can also qualify for allowances.

The proposal of the Finance Member embodies a sound principle calculated to further scientific and industrial research in India. Research is a social service where benefit is shared by the whole nation and represents the most fitting case to which such relief should be conceded. This reform in taxation measures was long over-due, and it is encouraging to note that the Government have at last realized its importance and have indicated their readiness to undertake the reform. The freedom from taxation of research funds is supposed to create conditions in which scientific and industrial research can make the largest contribution to the progress of the nation. This freedom, when secured, will serve as a great impetus to industrialists to make available larger sums of money for financing research projects which heavy burden of excess profit tax and income tax have normally prevented them from undertaking. If scientific and industrial research is to have its own way in the post-war period, this provision for relief from income-tax is a *sine qua non*. Although the idea originated in Britain, the Finance Member deserves to be congratulated for having taken a leaf out of that country's happenings and suggested a similar measure destined to exert a great influence on the future scientific and industrial life of India.

THE CELL-WALL AND IMPORTANCE OF ITS STUDY IN MODERN RESEARCHES

GIRIJA P. MAJUMDAR,

DEPARTMENT OF BOTANY, PRESIDENCY COLLEGE, CALCUTTA

Introduction

WHEN the cell was discovered by Hooke in the middle of the 17th Century its wall was regarded as *interstitia* and not its part. Long after, in early 19th Century, Paul Moldenhawer demonstrated by his new method of maceration that each cell had a *wall* of its own. This led to the study of the origin, structure and growth of the cell wall. The most outstanding contribution in this connection was made by Nägeli and von Mohl. Eames and MacDaniels (1925) writing about these authors say "Grew and Malpighi laid a substantial foundation for the science of plant anatomy ; Nägeli and Mohl built the superstructure. More recent workers have determined the principles of construction and elaborated the superstructure, adding details, but have modified the framework only in minor ways".

In a cell the living protoplast is the structural and functional unit, but there can be no doubt that the membrane (C. W.) which surrounds it plays a part of considerable importance in its life processes and the cell-wall may be regarded as the non-living record (?) of some of the metabolic activities of the protoplasm. The mechanism of deposition of such a wall and its further growth and development are as yet imperfectly understood, but the application of modern methods of investigation has helped us to a great extent in understanding the submicroscopic morphology of the cell-wall, and also has yielded information of considerable importance to the solution of the problem of its growth.

Importance of Its Study and Scope

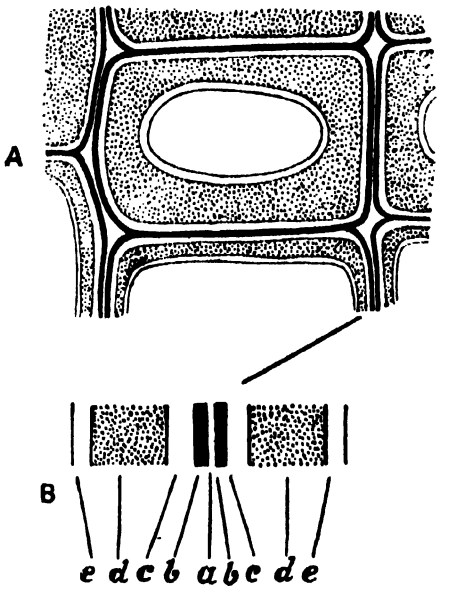
Apart from possessing a general scientific interest the study of the morphology of the cell-wall, particularly of fibres, has some practical objectives of importance to industry, such as, the phenomena of penetration of wood by preservatives, digestion of pulp wood, easy separation of fibres for textile purposes, and so on (Scarth, Gibbs and Spier, 1929). All these require a clear understanding of the chemical and physical properties of the intercellular substance (middle lamella), the primary and secondary layers. Much work has been done on cell-wall anatomy in other countries, but in India the importance of its study has only recently been realised and so far as I am aware, its study has been undertaken by Kundu, Banerji and Ray and Sarcar on jute and other fibres of economic importance.

The study of the cell-wall is a problem to success-

fully solve which a thorough knowledge of botany, chemistry and physics is necessary. The botanical aspect *i.e.*, the growth and development of the cell-wall is as important as the determination of its chemical changes taking place in the walls during the growth and differentiation of a cell. Again a thorough knowledge of some of the branches of physics is essential in order to investigate and understand the submicroscopic structure of the cell-walls from their physical properties, such as, anisotropy, porosity, hydration, etc., by applying such methods as *X*-ray analysis, examination under polarising microscope, hydration, etc.

The Wall of Adult Cells

The adult wall is grossly divided into different regions due primarily to their difference in chemical and physical properties. Eames and MacDaniels (1925) divided it into *middle lamella, primary,*



Text Fig. 1. (From Bailey). A. Diagrammatic cross section of a tracheid with parts of seven others. B. Enlarged section of a common wall illustrating the terminology applied to different layers of the wall, more highly magnified.
a. Truly isotropic intercellular substance (=middle lamella), *b.* primary wall, *c.* outer layer of secondary wall, *d.* central layer of secondary wall, *e.* inner layer of secondary wall (tertiary of Eames).

secondary and *tertiary layers* or walls. Later researches, particularly that of Kerr and Bailey (1934), have proved that the so called middle lamella is really different from the cell-wall. Bailey and Kerr therefore proposed the following terminology for the *distinct* layers of the wall:

(1) ***Middle lamella*** or the intercellular material: amorphous, isotropic, mainly composed of pectic compounds, often lignified (Manging, 1888-91, Allen, 1901, Ritter, 1925, Harlow, 1927, Majumdar, 1940 and others).

(2) *Primary Wall or Cambial Wall* or its homologues: faintly anisotropic, more of pectic than of cellulose material, capable of growth and extension and can undergo reversible changes in thickness.

(3) *The Secondary Wall*: additional wall layers deposited within the primary wall; positively anisotropic, lose their potentiality for growth and extension.

Anderson (1935) thinks that this terminology may be used without danger of being misunderstood. But Majumdar and Preston (1941) consider that the terminology proposed by Kerr and Bailey cannot be applied to all cell-walls. If a cell is extending with no obvious changes in wall thickness as happens in fibres, then the wall may be referred to as *primary*, and when a cell has ceased to extend, subsequent wall depositions may be called *secondary*. But in cases like collenchyma where the layers of thickness are deposited long before extension has ceased the wall can neither be called, according to Kerr and Bailey's definition, primary nor secondary. Therefore nomenclature of wall morphology proposed by Kerr and Bailey is much too rigid to include types like collenchyma. Majumdar and Preston have, therefore, suggested 'thickened primary' for such walls.

Again detailed investigation of the wall of the collenchyma of *Heracleum* (Majumdar, 1941, Majumdar and Preston 1941) has shown clearly that the wall of the adult cell is composed of *three* distinct zones; a peripheral, an intermediate region of cellulose lamellae embedded in intralamellar pectic substances, and an inner zone. These three regions differ from one another in both chemical and physical properties. The outermost layer is less extensible and less able to respond to swelling reagents, and under various treatments frequently becomes ruptured in characteristic ways when the intermediate cellulose layers swell out in a balloon or spiral like manner. The recognition of these distinct layers in the wall raises the question as to whether the term *tertiary* should be retained for the innermost layer which differs both chemically and physically from the outer zones.

Methods of Investigation

The following methods are employed (Anderson, 1935; Miller, 1938; Frey Wissling, 1939):

(1) *Direct observation of untreated walls* reveals presence of definite layers, surface markings, striations, radial lines, pits, unequal thickness, etc.

(2) *Use of specific solvents, e.g.*, of cellulose, pectin, lignin etc., their extraction and examination.

(3) *Colour reactions*—phloroglucinol tests as an

index of lignification, methylene blue and ruthenium red tests for index of pectination, etc.

(4) *Differential staining*—staining depends largely upon H-ion concentration and the iso-electric point of the material to be stained, *e.g.*, fixing material in chromoacetic acid and then using basic and acidic dyes of contrasting shades, and then washing in buffer solution of certain critical H-ion concentrations (Nayor, 1926).

(5) *Ash analysis* to find out kind of and various minerals in the wall.

(6) *Use of polarising microscope* to distinguish isotropic from anisotropic substances ; it also furnishes information on the orientation of the submicroscopic units of the wall.

(7) *Use of Spierer lens*—images produced by this lens indicate presence of definite structural units of ultramicroscopic dimensions ; provide evidence of micellar structure of the cellulose walls. Seifriz (1936) named these units 'super micelles'.

(8) *Measurement of refractive indices*.—different lamellae of the walls have different refractive indices.

(9) *Use of fluorescent light*—This detects degree of lignification of the walls ; they are irradiated with ultra-violet rays which on passing through lignified walls become visible due to fluorescence. Intensity of fluorescence varies with degree of lignification.

(10) *Hydration* Under different swelling reagents structural relations appear that are invisible under unswollen state ; lamellae are counted by this method.

(11) *X-ray analysis*—indispensable for knowledge of ultimate structure of the cell-wall. By this method actual size of the molecular and atomic aggregate in the wall, their distance apart and their spatial relationships are studied.

Conclusions so far arrived at from such studies may be indicated as follows :

(1) *The cell-walls are not chemically homogeneous* : Chemical substances that may enter into the composition of the cell-wall are :—

(*a*) *cellulose*—typical α, β, γ, types, hydrocellulose, oxycelluloses ;

(*b*) *hemicelluloses* or pseudocelluloses which include pentosans, xylan, araban, galactosan and mannosans ;

(*c*) *pectic substances*—pectic acid, pectates, pectin ; *lignin, suberin, cutin* and other constituents like resin, gums, tannin, minerals, colouring matters, proteins, fats, alkaloids, phospholipides, etherial oils, callose and others.

(2) *The cell-walls are not physically homogeneous* : The cell-walls under different treatment show definite lamellation (which usually vary in their refractive indices), striations and surface markings of various kinds. They also show anisotropy of swelling, of tensile strength, of absorption (dichroism), of refraction, and porosity (Frey Wyssling, 1939). To these Frey Wyssling adds *holopermeability* for salts and sugars, *penetrability* for colloidal dye stuffs like Congo red. Further the fibres of cellulose can be transformed into fibres of cellulose esters, such as nitro-cellulose or cellulose acetate without dissolving them or changing their form. Such transformation has been named by F. Wyssling as *permutoid* or *topochemic* reactions.

Origin and Thickening of the Cell Wall

To explain growth in thickness of the cell wall Mohl (1853, 1858) advanced his well known *Theory of Apposition*. In 1864 Nägeli suggested that the cell wall was composed of submicroscopic units or *micelles*, crystalline in nature, arranged in definite layers ; each micelle was surrounded by a film of water and that growth involved in the intercalation of new micelles between the old ones (*Theory of Intussusception*). The exact mechanism of the origin and cell-wall growth is not distinctly known. Whatever little is known is based on the study of walls of fibres, such as rhea or ramie, flax, cotton, jute, etc.

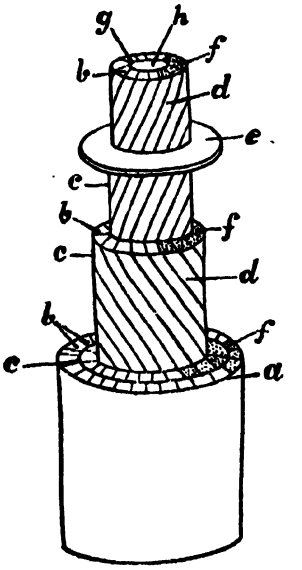
According to Aldaba (1927) the wall originates by a process of transformation of hyaline membranes. Farr and Eckerson (1933-34), and Farr and Sisson (1934) think that in cotton fibres during development they have been able to prove the presence of free ellipsoidal particles of cellulose covered with a thin layer of pectic substance in the cytoplasm (*Ellipsoidal Particle Hypothesis*). They think these have something to do with the deposition of wall layers. Anderson and Kerr (1938) on a reinvestigation of the cotton fibre found the so-called ellipsoidal particles in the cytoplasm to be really small plastids containing starch. They forthwith discarded this theory of Farr and his co-workers.

Sponsler (1934) is led to believe that in the process of cell wall formation units of monosaccharoses are condensed into polysaccharose chains, the bordering protoplasm taking an active part in the process. Lüdtke (1931) in wheat plants found whole series of intermediate products from saccharose (xylose and glucose) to cellulose formation in a series of transitional stages. Bonner (1935) considers young cell-wall to be living (*cf.* Wiesner, Hansteen-Cranner, Eames and MacDaniels (1925), Sharp (1934) ; Wood (1924), however, considers the presence of significant amounts of protoplasm in the cell wall to be improbable). Bonner and Heyn (1935) consider that certain ions enter the wall from the protoplasm, cause greater repulsion between micelles and an increase of micellar hydration, thereby increasing the plasticity of the cell wall.

The Fine or the Ultra-Microscopic Structure of the Cell Wall

The micellar theory of Nägeli has been proved to be substantially correct by modern investigations. The work of Frey (1926-28), Frey Wyssling (1930), Herzog (1925), Astbury, Marwick and Bernal (1932) *with polarised light*, and of Meyer and Mark (1928), Meyer (1929-31) and Clark (1930) *with X-ray examination* proved that the cell wall is composed of sub microscopic units or *micelles* which are elongated and of a crystalline nature. The crystalline micelles are separated from one another by a non-cellulose intermicellar *hydrophilic* colloidal material. The hydrophilic nature of the material is proved by the fact that organic liquids like ether, chloroform, fail to cause swelling of the wall when immersed in them. The micelle is composed of a bundle of basic cellulose groups or molecules. The basic cellulose molecules appear to be in long glucose residues (glucose minus a molecule of water). Length of a chain has been variously estimated to be from 50—1000 of these glucose residues (Meyer, 1929; Sponsler, 1929, '30, '31; Freundenberg, 1932; Seifriz, 1934; Gibbs, 1935). These chain like cellulose molecules are grouped in parallel rows into a bundle or micelle (Davidson and Richardson, 1936). The number of parallel chains present in a single micelle is from 40—60, its length is estimated to be from 50 to 100 mμ, and diameter from 2·0 to 6·6 mμ depending upon the source of material. Size may vary in different plant parts, or even in the same cell-wall. The forces that hold the glucose residues together in the long chains are the primary valence forces, while the forces holding the chains together in the micelle are those of molecular cohesion. In fibre cell the micelles are grouped into fibrils that collectively make up the cell wall (see also Kundu and Preston, 1940; Preston, 1941; Majumdar and Preston, 1941). Czaja (1934) after extensive studies of metachromatic staining finds that the molecular hypothesis adequately accounts for differential staining obtained (Anderson, 1935).

Sponsler (1926-33), and Sponsler and Dore (1926) consider that the evidence for existence of micelles as definite entities in the cell wall seems to be inadequate; according to them the wall is composed of long parallel chains of glucose residues running lengthwise of the fibre. The chains are oriented in such a way as to form a spatial lattice of three dimensions. The cellulose wall is thus considered to be a complex system built up of very thin molecular layers, each composed of long chains of glucose residues. Certain layers extend lengthwise of the wall, some extend across the wall and other layers form definite angles with the lengthwise layers. A single fibre cell-wall may be made up of some 40,000 of these lattice units in thickness. The wall of a fibre cell like cotton consists, according to Sponsler, of an enormous number of parallel molecular layers and not of a system of brick like units as suggested by the miceller hypothesis. Sponsler (1929) thinks that since the inner surface of the wall adjacent to the protoplasm has a definite molecular pattern the forces of crystallisation at this surface may form a part of the mechanism by which glucose molecules become converted into cellulose (Anderson, 1935).



Text Fig. 2. (After Lüdtke). Diagram of a small fragment of a cellulose fibre cut away to illustrate the structure of the wall: *a*. primary wall; *b*. layers of secondary wall; *c*. thin film of non-cellulose material separating the layers in the wall; *d*. spirally wound bundles of fibres; *e*. cross elements separating the fibre wall into segments; *f*. fibrils composing the spiral elements; *g*. innermost layer of the wall; and *h*. cell lumen. (From Anderson).

According to Hess (1928), Lüdtke (1931), Farr and Clark (1932), Farr and Eckerson (1933-34) and Farr and Sisson (1934), the cell wall is composed of definite cellulose units microscopically visible, each unit being enclosed in a thin film of non-cellulose material that serves to cement the units together. Farr and Eckerson consider this non-cellulose constituent to be pectic material with its nature apparently varying in different walls. This theory of cell-wall structure finds support in the behaviour of cell-wall during swelling, in dissolution by various reagents and in the reaction to certain dyes. Certain cellulose staining dyes frequently fail to impart colour to cellulose walls except when these walls are sub-

jected to mechanical pressure. This pressure ruptures the non-cellulose constituent and permits the stain to reach the cellulose particles.

In this connection the observation made by Majumdar (1940) on the chromic acid macerated collenchyma cells appears to be interesting. It is the iodine and saturated zinc chloride solution that gave the most interesting results. Iodine and zinc chloride solution gives a light blue colour reaction to cellulose. In transverse section this reaction is immediately noticed, but in macerated material a different action was observed. When macerated cells are treated with iodine solution and then immersed in zinc chloride they swell. The cells are white and lustrous except that in some cases transverse blue lines are seen in the thickness of the wall in the region of the bars. These lines are variously distributed, sometimes closely spirally, sometimes distantly. In optical section they are seen in the outer part of the wall but do not reach the lumen ; in surface view they are often seen to stretch right across the cell. After some time the light blue colour is seen to spread along the surface as individual patches up and down from the transverse blue lines. It takes a comparatively long time for the whole cell to turn light blue, but generally the blue reaction is confined to the region of the cell where these transverse streaks first appear, while the remaining regions, in many cases, remain without any colour. When, however, the cell is treated with zinc chloride first and then iodine solution the whole of it at once takes a brownish or violet colour characteristic sometimes of cellulose.

The explanation of the above phenomenon appears to be that when zinc chloride causes the swelling of the inner layers the outer layer cracks and through these cracks iodine enters and turns the cellulose layer blue, then iodine diffuses through the lamellae up and down, and the colour reaction spreads. It starts from the individual cracks and then moves along the cellulose lamellae, and if the cracks are very close the whole region is stained by the coalescence of all the light blue patches. These transverse and irregularly transverse cracks appear to be responsible for the characteristic ballooning described in collenchyma and other fibres (Kundu and Preston). This is quite in accord with the explanation given by Anderson and Kerr (1938) of a similar phenomenon observed by Sakostschikoff and Korsheniovsky (1932) in 18—20 days old cotton fibres stained with strong chlorzinc iodine solution. The outer layer (p.w.) always appears quite distinct. It gave faint signs of darkening with osmic acid, but hardly so pronounced as to allow any definite conclusion to be drawn.

Anderson and Kerr (1938) hold that cellulose in primary wall (p.w.) forms an open meshwork of fine thread like strands that frequently anastomose. These strands can be made visible by staining the wall with Congo red or chlorzinc iodide and examining between crossed nicols. Balls (1919) found two opposing systems of fine spirally wound threads of cellulose in the walls of 10 days old fibres. When the long axis of fibre makes an angle of about 45 degrees with the planes of nicols a third system of transverse strands of cellulose becomes visible in many fibres. Therefore Anderson and Kerr assume the presence of three systems of fine thread like strands in the make up of the cellulose frame work of the primary wall.

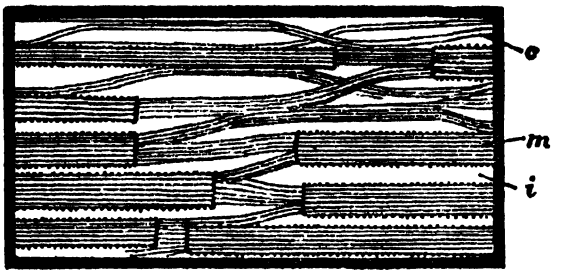
According to these investigators the first secondary deposition takes place as a layer of anastomosing strands that wind in a steep spiral (20 to 30 degrees) around the inner surface of the p.w. with frequent reversals. The cause of the laminated or stratified nature of the secondary wall (s. w.) is little understood. Balls thinks that there is a correlation between the number of lamellae and the number of days during which thickenings take place. But Kerr (1937) contends that the wall is a continuous matrix of cellulose and the laminated appearance in swollen sections is due to alternations of dense and less dense zones of cellulose. He showed that when cotton plants are grown under constant illumination and at approximately constant temperature no growth rings are formed in the fibre wall. He thinks that the distribution and thickness of growth rings in the wall of the cotton fibre can be varied at will.

Collenchyma cells of Heracleum (Majumdar, 1940) show beautiful lamellation of their walls when macerated by retting in water, or in 5% chromic acid. Staining reactions show the presence of pectin-rich-cellulose-poor lamellae alternating with pectin-poor-cellulose-rich lamellae. Retting in water completely removes the pectin—rich—cellulose-poor layers. Strong hydrochloric acid treatment of sections also does the same thing. In water retted fibres iodine followed by 60% sulphuric acid gives a pronounced cellulose reactions and the wall become clearly lamellated showing light blue and dark blue zones alternating throughout the whole wall thickness.

Lüdtke's conception of the cell wall seems to explain certain facts better than other theories. The wall is built in segments separated by definite cross elements. The lamellae are believed to be caused by very thin films of non-cellulose materials enclosing bundles of spiral fibrils which serve to act as a glue binding the cellulose segments together in the wall. This structural system is based on the behaviour of cell walls during swelling and solution in various reagents, and the reaction of fibre cells to certain dyes, especially chlorzinc iodide noted above.

Bailey and Kerr (1935) think that there is no reliable evidence to indicate that the matrix of the

cell wall is composed of entities of visible size bound together by a non-cellulose material. They believe that such putative entities are actually heterogeneous fragments that are shredded or disrupted from an originally continuous and coherent matrix. If these are discontinuous in the structural pattern they are confined to the submicroscopic field, *i.e.*, the realm of micelles and molecular chains.



TEXT FIG. 3. Scheme of the submicroscopic structure of a fibre by Frey Wyssling. *c* = Cellulose chains; *m* = crystalline cellulose (= micelles *sensu* nugeli), *i* = intermicellar spacings (from *Sc. Progr.*)

Frey Wyssling in 1935 proposed at the International Botanical Congress a modified scheme of the Micellar Theory (1936, 1939). The difficulty with regard to the original theory of Nägeli arose in this way: The crystalline nature of the micelles were re-established by Meyer and Mark in 1930. But its brick like structure as envisaged by Seifriz (1929) was criticised. How can a brick like structure show such tensile strength as is found in textile fibres? Meyer and Mark thought that the cohesive forces between the crystallites would be sufficient. Then the controversy arose about the length of the molecular units. The X-ray analysts showed a minimum length of about 600A, whereas Staudinger (1932) measured by his viscosimetric method cellulose chains of 10,000 to 15,000A, *i.e.*, 1 to 1½ μ in length. Frey Wyssling's modified scheme, he thinks, satisfies both points of view. The X-ray analysis of fibres (Astbury, 1933; and Meyer and Mark, 1930) confirmed the result that the fibres must be built up of crystalline *rodlets* of cellulose. Hengstenberg and Mark (1928) calculated that the rodlets are about 60A broad and at least 600A long. Both the polarising and X-ray methods furnish the same result, and establish definitely, that the fibre walls are *rodlet mixed systems*. According to Frey Wyssling "the cellulose chains are several times longer than the crystalline micelles revealed by the X-ray analysis. There must be regions where these chains crystallise together and other regions where they are not sufficiently close or regularly parallel to form a crystalline lattice. In the older theory the cellulose was the dispersed phase and the intermicellar system the dispersion medium, while here the intermicellar spaces appear dispersed within the cellulose as a dispersion medium". Then by deduction he envisaged a *reticular system* holding that the micellar and intermicellar systems are continuous and penetrate each other (*cf.* Bailey, 1938, where he speaks of the existence of two continuous interpenetrating system). Therefore, the micelles of Nägeli correspond to crystalline regions within a continuous, porous structure. In this scheme individual micelles do not exist. The cellulose chains are very long, slender, and practically endless. They form a micellar framework with crystalline regions which cause the remarkable *intrinsic double refraction* first discovered by Ambronn in 1910, but significance not understood at the time. He seems to have proved further that the intermicellar system of cell wall is an intercommunicating *heterocapillary* one. The anisotropic swelling is caused by the uptake of water into the intermicellar system and the unusual penetrability of this system is explained by its continuity, which permits rapid diffusion in all directions. The discrepancies of density and double refraction are caused by the empty spaces in the micellar system.

The following conclusions may be drawn from facts so far accumulated:

(1) Chemically the cell wall is heterogeneous.

(2) Physically the cell wall is also heterogeneous including optical heterogeneity.

(3) The cell wall is extraordinarily anisotropic.

(4) The cell wall is submicrospically porous.

(5) It is also holopermeable to salts and sugars, and permeable to colloidal dye stuffs like Congo red. It also gives permutoid or topochemic reactions.

(6) The cell wall can be divided into primary, secondary and perhaps into tertiary layers or regions. The lamellae differ in chemical and physical properties.

(7) The skeletal framework of the wall is made up of practically 'endless' cellulose chains forming a micellar framework with crystalline regions (= micelles of Nägeli), called by Frey Wyssling a reticular system. The intermicellar system is a continuous *heterocapillary* system.

(8) The chains are oriented, almost longitudinally, parallel to the fibre axis, but in the majority of cases a *spiral* structure, flat or steep, obtains.

(9) The intermicellar spaces are filled with non-cellulose materials of amorphous and colloidal nature.

(10) During the stretching of the primary wall the orientation of the submicroscopic structure also changes, as in collenchyma; in walls of fibres, like jute and hemp, during development the inclination of the originally spirally wound initial changes in accordance with change in dimension at some stage of growth.

Selected Bibliography

Aldaba, V. C., *Amer. Jour. Bot., 15,* 16, 1927.
Anderson, D. B., *Bot. Rev., 1,* 52, 1935.
Anderson, D. B. & T. Kerr, *Ind. Enb. Chem., 39,* 48, 1938.
Astbury, W. T., Fundamentals of Fibre Structure, Oxford, 1933.
Bailey, I. W., *Ind. Eng. Chem., 30,* 40, 1938.
Bailey, I. W. & T. Kerr, *Jour. Arn. Arbor., 16,* 273, 1935.
Bonner, J., *Jahrb. wiss Bot. 82,* 377, 1935.
Clark, G. L., *Jour. Ind. Eng. Chem., 22,* 474, 1930.
Davidson and Richardson, *Sc. Prog., 31,* 62, 1936.
Farr, W. K. and G. L. Clark, *Contr. Boy. Thom. Inst., 4,* 273, 1932.
Farr, W. K. and S. H. Eckerson, *Contr. Boy. Thom. Inst., 6,* 189, 309, 1931.
Farr, W. K. and W. A. Sisson, *Contr. Boy. Thom. Inst., 6,* 315, 1934.
Frey, A., *Bull. Soc. Bot. France, 75,* 950, 1927.
Freudenberg, K., *Jour. Chem. Educn., 9,* 1171, 1932.
Frey-Wyssling, A., *Sc. Progr., 24,* 249, 1939.
Gibbs, R. D., *Can. Jour. Res., 12,* 715, 1935.
Hengstenberg and Mark, *Z. Kryslallogr., 69,* 271, 1928.
Hess, K., *Biochem. Zeit., 203,* 409, 1928.
Kerr, T., *Protoplasma, 27,* 229, 1937.
Kerr, T. and I. W. Bailey, *Jour. Arn. Arbor., 15,* 327, 1934.
Kundu, B. C. and R. D. Preston, *Proc. Roy. Soc. B, 123,* 214, 1940.
Lüdtke, M., *Biochem. Zeit., 223,* 1, 1931.
Majumdar, G. P. and R. D. Preston, *Proc. Roy. Soc.* B, *130,* 201, 1941.
Miller, E. C., Plant Physiology, N. Y., 1938.
Meyer, K. H., *New Phyt., 30,* 1, 1931.
Norman, A. G., *Sc. Prog., 28,* 229, 1933.
Preston, R. D., *Chron. Bot., 7,* 414, 1943.
Ritter, G. J., *Ind. Eng. Chem., 17,* 1194, 1943.
Scarth, G. W., R. D. Gibbs and J. D. Spier, *Trans. Roy. Soc. Canada, 23,* 269, 1929.
Seifriz, W., *Protoplasma, 21,* 139, 1934.
Sponsler, O. L., *Jour. Amer. Chem. Soc., 56,* 1599, 1934.
Sponsler, O. L. and W. H. Dore, *Colloid Symp.* Mono. *4,* 174, 1926.
Staudinger, Die hochpolymeren organischen Verbindungen, Berlin, 1932.
Sakostschikoff, A. P. and A. Korshenievsky, *Faserforschung, 9,* 249-84, 1932.

CONSERVATION OF METAL RESOURCES AND THE FUTURE OF GLASS INDUSTRY WITH SPECIAL REFERENCE TO POST-WAR PLANNING IN INDIA

ATMA RAM

CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, DELHI

(Continued from the last issue)

In a recent publication[1] the writer described the development of the modern Indian glass industry. The early attempts to establish the industry had not been very successful and even the association of a number of foreign experts such as Germans, English, Austrians etc. did not prove very helpful. Some of these factories, however, struggled hard and exist even to-day, though under different names. A careful analysis of the so many failures in these early attempts leads one to ascribe them to the following reasons:—

1. Lack of efficient organization and quarrel between experts and financiers.
2. Foreign experts' ignorance of Indian conditions and financiers' impatience for quick results.
3. Lack of technical skill on the part of Indians and consequent dependence upon foreign experts.
4. Improper location of the factories in some cases, as for example a factory at Rajpur (on the Dehradun—Mussoorie Rd).

[1] Atma Ram, *J. Sci. & Ind. Res., 3,* 66, 1944.

The Japanese methods initiated by Mr I. D. Varshney were successful and the reasons might have been the suitability of the Japanese furnaces to small units, comparatively less expenditure in the initial stages and the ease of working them. Further no machinery was required for Japanese types of furnaces. This success was largely achieved due to the supply of workers trained at the Paisa Fund Training Centre, Ambala and Bahjoi mainly through the efforts of Mr I. D. Varshney, the doyen of the Indian glass industry. The workers trained under German workers helped in the growth of the glass industry, since their methods of working were better than those of the Japanese. The technical staff of several of the present leading glass factories in India has either been trained at these works or under persons who received their training there. In fact, the Indian Industrial Commission paid a tribute to the ability of the glass industry to supply the demands during the last Great War mainly to the efforts of this training centre and appreciated its work in the following terms.

"Useful work has been done by the Paisa Fund at Talegaon Glass Works and it is certain that the recent

developments of the glass industry in India have only been possible by reason of the blowers trained in this factory".

While, as a result of the war impetus, the industry was undergoing expansion in the country, an event of a rather threatening character, which in the post-Great War years brought the Indian Glass Industry almost to the verge of ruin, also happened during this period. Japan seized the opportunity when other exporting countries were engaged in the war and established a very substantial market in India where it had almost no position before the war. In spite of all the efforts, India could only supply a part of country's requirements. During the four years of the last Great War, the Japanese imported very large amount of machinery from the U. S. A. and established a well organized glass industry based on mass production.

Apart from the development of this industry on modern lines, the manufacture of glass bangles, a specialized article of Indian requirements, was also being pushed on in India chiefly at Firozabad in the United Provinces where it is said to have been started from the Mughal days. This began entirely as a cottage industry with very little co-ordination and the art of making bangles has passed down from generation to generation with the result that there is now a definite class of Muslims at Firozabad known as Shishgars (the glass makers). During the early days, bangle-makers used local made crude glass and broken pieces and melted them along with soda ash from reh or with saltpetere in their crude wood-fired furnaces. The products were not very attractive and could be sold only at very low prices in comparison with the superior imported Czechoslovakian and Japanese bangles. One of the reasons why this branch of the glass industry did not face many failures, although not very prosperous, was the indigenous character of the technique ; it was not an imitation of other people's practice ; also it did not require large furnaces, complicated machinery etc., hence it did not involve much capital expenditure and consequently it had less risk of heavy losses. It is estimated that during these attempts the country suffered a total loss of about half a crore of rupees even in these small adventures.

These scattered attempts continued till the outbreak of the last Great War in 1914, which gave an impetus to the glass industry due to the stoppage of imports from the major exporting countries such as, Germany, Austria, Belgium etc. The production of the older units increased and new factories were started to meet the sudden demands. Several glass bangle factories were also started at Firozabad and it was during this period that this section of the industry became somewhat established at this centre. The industry had thus considerable expansion in its activities.

Condition of the Glass Industry in the Allied Countries during the last Great War

It may not be out of place to mention here that the condition of the glass industry in some of the principal Allied countries was not very satisfactory at the outbreak of the last Great War. For instance, in England, a considerable portion of her requirements particularly in optical and scientific glassware, was supplied principally by Germany which was at that time sufficiently far advanced in the technique of glass manufacture. Due to the unsatisfactory condition of the home industry and the total stoppage of all exports from Germany, Great Britain was exposed to severe hardships. In this connection the following remarks of Professor Turner are worthy of mention :

"The glass industry is carried on very largely by rule-of-thumb methods.

No courses of instruction in glass manufacture appear to be given in the United Kingdom.

Very little trustworthy literature exists in the English language on the subject of glass manufacture.

There is great need of research in glass-making processes".[2]

"We all know fully well how certain industries had to be created; the production, for example, of scientific glassware, such as flasks, beakers, and all other types of apparatus ungraduated or graduated, almost all of which had been imported before the war, had now to be made, and in very large quantities, in order to supply, not only the scientific institutions which were important customers before the war, but also the innumerable laboratories set up to control all kinds of war munitions. Optical glass now needed in a vastly increased quantity for naval and military purposes had to be provided. The lamp working industry, which did not exist as an industry, or, at any rate, was a wholly negligible quantity, assumed enormous dimensions and supplied all sorts of surgical glass instruments, mine-horns and general scientific ware."[3]

War is a dreadful happening, but such times also bring home many deficiencies in the organization of the country. For instance, regarding the industries and their functions, the last great war clearly demonstrated :

(1) That industries play a very fundamental rôle in ensuring prosperous and stable conditions for the welfare of the country, both in times of peace and war.

(2) That as such the State being the ultimate custodian of the interests of the people is responsible to ensure that the industries are properly developed.

(3) That State measures in their different forms such as tariff protection, technical aid, financial assistance etc., can be effective in creating circumstances for their healthy development.

(4) That no industry which does not bring to its aid the application of scientific knowledge can hope to survive in modern industrialization, and consequently application of scientific knowledge and

[2] Turner, W. E. S., *J. Soc. Glass Tech.*, *20*, 1, 1937.
[3] *Ibid.*, *5*, 139, 1922 .

abundant and regular supply of trained workers constitute one of the fundamental essentials for industrial development.

Even before the last Great War, many of the glass producing countries, for instance, Germany, France, the U. S. A., Switzerland etc., had been following the policy of protecting the industry from unfair foreign competition. The U. S. A. granted protection to the extent of 60-80%. The last Great War brought home to these countries the necessity of developing these industries so that they could be independent of foreign exports. The production of glass articles of different varieties expanded in all the countries and new industries, particularly scientific glassware and optical glass, were created.

Post-Great War Development in other Countries

(*a*) *Introduction of the Machine and its Influence on the development of Glass Industry.*—An important event in the history of glass industry during this period was the increasing use of machinery in glass manufacture. Before the Great War, although few machines such as Owen's machine had been invented, and their use had proceeded beyond the experimental stage, they were not largely in use. During and after the Great War, there was a rapid and widespread introduction of machines both automatic and semi-automatic for different processes of glass manufacture and practically the entire character of the industry both commercial and technical underwent a fundamental change. In mechanization, although different countries have taken part, it is largely the American talent that has made the manufacture of glass a highly mechanized industry for mass production. The introduction of machines has had a very great influence on other branches of glass manufacture such as the type and size of furnaces, the kind of fuel used, the type of raw materials etc. Moreover, the introduction of the machines had a great effect upon the location of the industry, it being no longer necessary to locate factories in the areas guaranteeing availability of skilled glass workmen. The training of both the operatives and supervising staff based on an understanding of fundamental scientific principles assumed a central rôle in the development of the industry. Whereas, the credit of inventing the machines goes principally to the inventors ; their real success on a commercial scale has in no less degree been due to the combined efforts of the physicists and chemists by placing at the disposal of the operatives the type of glass best suited to the particular machines. For instance, the success of the automatic blowing machines has been possible through the supply of proper type of glass, having the requisite characteristics of viscosity.

(*b*) *Beginning of the Science of Glass Technology.*—Although the art of glass manufacture had attained a sufficiently high degree of perfection in some of the European countries such as Germany, Austria, England, Czechoslovakia, etc., most of the processes and their implications, if at all understood, were still closely guarded secrets of the inventors and manufacturers. The art of making optical glass was almost a monopoly of the firm of Schott and Abbe of Germany. As such, the manufacture of glass mostly remained a skilled art of the practical glass maker without its scientific basis being understood. One of the important events brought about by the happenings of the Great War which changed the entire aspect of the manufacture of glass was the application of science which gave birth to modern glass technology. It was realized during this period that without a proper understanding of the scientific implications of the processes glass industry could not make a headway. Several laboratories were opened in different countries ; scientific societies dealing with glass were organized and several important organizations were established. The various laboratories that were started during and after the war have provided not only the place for the discovery of new processes and understanding of the old ones but have also been largely responsible for a supply of trained workers who are the back bone of modern industries.

The basis of each operation is being understood in the light of scientific knowledge. The feelings of empiricism and secrecy, so common in the pre-Great War period, have disappeared making room for the full fledged science of glass technology. It is natural, therefore, that those who still believe in secrecy and empiricism cannot expect to stand in the field of competition backed by scientific findings and training.

Post-Great War Conditions in India

Thus the period following the last Great War witnessed a steady progress towards perfection of the glass industry in Europe and America. In India, however, the industry had a different history in the Post-Great War period.

Shortly after the conclusion of the war, imports of glassware began to pour into India at a very rapid rate and the temporary prosperity enjoyed by the industry due to abnormal conditions created by the war almost disappeared. Such a sequel was, in fact, predicted by the Indian Industrial Commission who based their argument on the finding that other neutral countries had also developed their resources, particularly the manufacture of glassware. Moreover the belligerent countries after return to normal conditions began to intensify their industrial activities with a view to get back lost markets. The Indian glass industry which was still in its infancy fell an easy

prey to such conditions with the inevitable result that the market was dumped by foreign imports, and several factories had to close down. As a matter of fact, the year 1920-21 witnessed the highest imports (Rs. 3½ crores) of glass articles into India.

The glass bangle industry also had had a bad shaking and the market was full of the Japanese type of bangles (Reshmi) which were cheap and attractive. This severe external competition brought in its trail internal competition with the consequent decline both in quality and quantity of the goods produced. The industry struggled and passed through the worst phase of its existence till the Swadeshi Movement of 1930. The Indian articles again appeared on the market in increasing quantities. During this period there was an all-round improvement in the different branches of the industry and the quality of the articles improved considerably. The manufacture of scientific glassware was also initiated and this has been responsible for meeting the demands of this type of glassware during the present war.

Present Position of the Industry

It was under these circumstances that the present war broke out which has again given a great impetus to the Indian glass industry. The import of glass articles into India has substantially diminished and there has been considerable expansion in the activities of the industry. In addition to the increased production of the already produced glassware, some new types of articles such as electric bulb shells, neutral glass, signal glass, boiler gauge glass have been produced, and although their quality may not, in some cases, be comparable to that of the imported stuff, they have succeeded in meeting the war requirements of the country. Prior to this period, having passed through a state of chronic depression and, consequently, of technical backwardness, the industry has not been able to fully utilize the opportunities created by the war and many important and key materials such as optical glass, toughened glass, fibre glass, foam glass, etc. which have made glass an article of war strategy, are not produced in the country.

The industry is concentrated in a few centres mainly western U. P., Calcutta and suberbs and the Bombay area. Factories are, however, scattered all over the country and although so far no particular attention has been paid in deciding the location of factories, consideration of the availability of market in the area appears to have had a predominating influence in such selections. The total number of factories including glass bangle factories of Firozabad is about 150. There is quite a large number of small cottage bangle works not covered by the Factories Act and these together produce a substantial portion of the total quantity of glass bangles produced in the country. The size of the glass factories is not very large, and the number of factories with a capital exceeding a few lakhs of rupees is indeed very small. The biggest glass factory in the country is the U. P. Glass Works which, although the oldest and biggest producer of sheet glass, also manufactures different type of blownware articles.

The total production of glass articles in the country before the war including that of glass bangles was valued at about one and a half crores of rupees. The present figures for the production of glass articles are not available and, even if they are, they cannot be very reliable in view of the high fluctuations in prices. Moreover, due to the scarcity and control of many of the materials and fuels the total production capacity of the industry has never come into play. It is believed, however, that in tonnage the production of the glass articles has become doubled.

The quality of the articles produced in India had shown improvement before the outbreak of the present war, but of late due to several reasons such as the restricted supply of chemicals, shortage of fuels, difficulty of transport, and also in the absence of foreign competition every article having become saleable, the quality of the products has somewhat deteriorated. The appearance and finish of the articles are not very satisfactory. They are rather dull and in some cases are even deformed. The annealing is poor, and this is one of the major defects of the Indian products. Due to bad annealing, Indian made articles give way under slight changes of temperature ; their mechanical strength is also low. The articles develop cracks during storage. In some of the factories, the annealing kilns are of crude designs and are wasteful in fuel and unhealthy to workers. In the absence of a properly determined annealing schedule, the routine procedure, as practised, has hardly any value. In these days of shortage of fuel and chemicals, it can easily be realized that if the technique and operation of annealing which is one of the most important operation in glass manufacture can be properly organized, the quality of the glass goods will considerably improve, and the amount of fuel and chemicals required on an overall basis will also be reduced.

There is at present, with very few exceptions, very little control exercised on quality during production. Most of the operations are still carried out by the rule of thumb, and secrecy still guides the field of manufacture.

There has been a tendency towards the employment of better types of furnaces, but in many cases the subsidiary furnaces such as the annealing kilns, glory holes, etc. are very disappointing, particularly

in view of the great developments that have taken place in this particular field.

With the exception of a few centres that have been training students in glass technology and the advice and help which the manufacturers may have been receiving from the Government departments such as the Glass Technologist to Government, United Provinces, the Glass Chemist to Government, Bombay, there is no central institution to advise and help the industry in its efforts to develop on modern lines.

Very little information is available on the resources of raw materials required for the glass industry and much less about their properties. No organized survey of the raw materials has been carried out so far and unless the raw materials are properly charted, it is difficult to see how the industry can develop. The Industrial Research Bureau had organized the survey of glass raw materials and quite an extensive work was done, but so far no report on the results has been published.

Factors Favourable to the Industry

Let us now examine whether the glass industry in India has the essentials for its successful establishment in its favour or it is one which has to depend on imports from other countries. In any such examination, the following broad items have to be considered:

(1) Availability of raw materials; (2) Market; (3) Direction, both technical and commercial; and (4) Location of factories.

(1) *Availability of raw materials.*—The basic raw materials required in the production of glass are sand, soda ash and lime. The other materials required for special purposes are felspars, manganese dioxide, zinc oxide, lead oxide, borax, selenium, arsenius oxide, cobalt oxide, chromium oxide, sulphur etc.

Sands and lime are available in the country and with the establishment of the soda ash factory by Alkali and Chemical Corporation of India and the Tata Chemicals, Limited, this important material which has hitherto been imported from abroad will also be produced in the country. Some of the other materials required for special purposes are also available. Selenium, borax etc. are still imported, but after the termination of hostilities there will be no serious difficulty in obtaining these chemicals. Fuels and refractories, although not included amongst the raw materials, constitute an important item of expenditure in the production of glass. The material produced by the refractory manufacturers in the country is regarded as satisfactory. Prior to the declaration of war, pots required in glass manufacture used to be imported from Japan, but in the absence of Japanese imports a number of glass works are making their own pots. The Ganga Glass Works, Balawali, which had been making some pots even before the outbreak of the present war, have specialized in this particular branch and their products have in some respects been found even superior to the imported Japanese pots. It may, therefore, be said that the resources of the principal raw materials are abundant in the country.

(2) *Market.*—Regarding the market, as already pointed out, India imported glass goods to the extent of about 1½ to 2 crore of rupees before the outbreak of war. The total production in India has been estimated at about the same figures. Moreover, with the increase of industrialization and general advancement in the economic life of the country, standard of living is expected to be raised. There is every possibility of greater utilization of glassware and, as already discussed, if the quality of the Indian glass can be improved the total consumption of these articles will increase very considerably. It is evident, therefore, that as regards market there is a wide scope for the industry.

(3) *Direction, both technical and commercial.*—Taken as a whole the glass industry is highly technical in nature and requires for its development a sound knowledge of sciences like physics and chemistry, and of engineering with special reference to furnace designing. The present advanced position of England, America and other countries in this industry is largely due to the increasing application of scientific methods to glass manufacture. In India, the present conditions of technical training in glass manufacture and arrangements for research are not at all satisfactory. It is to be feared that with the prevailing backward state of technical knowledge the industry may not be able to stand the severe competition to which it is likely to be exposed after the present war. The industry does possess natural advantages, and if it could have the benefit of trained Indian personnel there is no reason why it should not be able to establish itself more firmly than before. The present war more than anything else has brought into prominence the necessity of having trained technicians in the country.

There is plenty of labour available in the country for the glass industry and the average worker has shown remarkable aptitude and skill. It will not be incorrect to say that, given the opportunity, an average Indian worker will not be found inferior to any worker anywhere in the world. There is a great and urgent need for raising the technical standard of the personnel and for ensuring the supply of really capable and trained men to the industry.

(4) *Location.*—The proper location of the industry as one of the determining factors for its success is

now being critically studied practically all over the world. The P.E.P. (England) has recently published a very extensive report on "Location of factories in Great Britain". Location of factories is certainly a very debatable topic and can occasionally make all the difference between success and failure. The most salient points governing their location are constant availability of raw materials, nearness of markets, and supply of efficient labour and suitable climate. Some people, however, lay great emphasis on locating factories near the source of raw materials. This is, always not very helpful, and sometimes question of freight on finished goods and nearness of market become the deciding factor. Glass is a fragile article and liable to greater losses during transit if it has to be hauled over long distances. Being voluminous, the freight is also not inconsiderable. It is apparent, therefore, that the nearness of the market plays an important part in the location of the glass factories and this is evident from the success of so many factories far removed from sources of raw materials, such as those in northwest U. P. and the Punjab.

Potentiality of the Industry

From the foregoing account it is easily seen that the various factors which are considered essential for the success of any industry are such as to favour its growth and development in this country. A remarkable feature of the industry is that it shows signs of prosperity and progress whenever economic conditions such as those prevailing during the war which prevent the exporting countries from exporting glassware into India are obtainable. This has been amply demonstrated by the ability of the industry to meet the sudden demands created in the successive wars to the best of its capacity. After the last Great War it passed through a crisis which may have involved its very existence. That may be one of the reasons why the glass manufacturers have been rather too cautious during the present war, since without proper measures from now similar catastrophe may overtake them after the termination of present hostilities. Whenever conditions have been favourable, the industry has undergone expansion and improved the quality of its products. These happenings make it clear that there is nothing inherently wrong with the industry ; it has never enjoyed a period of prosperity to overcome the difficulties that have retarded progress.

Causes of the Backward State of the Industry

We may now analyze the various factors that have contributed to this stagnation in spite of the industry possessing potentiality for development and the essentials that govern the success of an industry being favourable to its growth. One who has read the history of the growth of this industry in other countries specially in the Great War and Post-Great War period will easily realize the important part which economic conditions and State aid have had on its growth. For instance, in England the glass industry particularly the manufacture of scientific and optical glassware which had undergone considerable expansion during the war, has had to face competition from foreign countries after the termination of hostilities, and it was ultimately in 1932 that the Import Duties Act afforded the necessary protection. The effect of these circumstances can be easily realized from the following words[4] of Prof. Turner:

> "The war period of some four and a third years gave these industries the opportunity for progress and consolidation; but commercial conditions in such a period are also different from those of peace times and it was feared by some that the strength of post-war competition from Germany and Czechoslovakia, which had previously been the source of supply, would be so great that the new industries might again relapse. But the lesson that chemical and general scientific glassware was a vital necessity for the control of munition's supplies had been thoroughly learned, and in consequence they were included in the materials which received special protection from the tariff imposed under the Key Industries Duty. This measure of state aid clearly gave, and has given, invaluable assistance".

After experiencing a heavy shake-up the Indian Glass Industry represented to the Government to have its case examined by the Tariff Board for protection and the Government agreeing to this request directed the Tariff Board (President, Dr John Matthai) to undertake the investigation. The Indian Tariff Board examined in a very critical manner the various causes that contributed to this stagnation and in a masterly analysis of these circumstances the Board came to the following conclusions[5]:

(1) "We are, therefore, satisfied that on the balance, the glass industry does possess certain natural advantages as to justify its claim for protection."
(2) "We are convinced that unless any tariff assistance granted to industry is supplemented by suitable organization for training and research, the progress of the industry will be slow and incommensurate with the burden which our proposals will place on the country."

The Tariff Board therefore recommended:
(1) grant of protection to the industry, and
(2) the establishment of a Central Institute in glass technology to help the industry in technical matters.

The Government, however, did not agree to the recommendations of the Tariff Board mainly on the ground that soda ash, one of the principal raw materials for glass, was not available in the country, but to help the industry they agreed to give a certain

[4] Turner, W. E. S., *Proc. Soc. Glass Tech.*, *22*, 28, 1938.
[5] *Rep. Indian Tariff Board*, *52*, 101, 1932.

amount of rebate on the amount of soda ash used. The idea of establishing a Central Institute receded to the background. Several years later, in 1938, the U. P. Government which is the home of the glass industry and particularly that of the glass bangle industry opened a glass technology section attached to the Department of Industries and appointed Dr A. Nadel as the Glass Technologist, who has continued in that capacity.

It is a well accepted principle that when any enterprise is to face serious competition from outside it invariably develops internal competition amongst its individual members. The Coal industry is another instance, where the price of coal before the war had fallen to a ridiculously low level and consequently there was increased adoption of crude methods of mining. The inherent consequences of such internal competition are wasteful methods of production, low wages, inferior quality of products and so on, which contribute to its rapid decline.

It is generally argued that the backward state of the industry is due to lack of application of scientific methods to industrial production which placed other countries in a strong position, but the application of scientific methods to produce the best products which may be called healthy competition is a consequence of prosperity and favourable economic conditions. It would be unwise to deny the paucity of trained men in the country, but the conditions had been so severe that even the few trained men could not find suitable employment in the country and their training obtained on a high expenditure almost could not be of any use. The internal competition produced a feeling of individualism and suspicion amongst the different manufacturers with the result that they could never organize themselves against foreign competition. After the Great War, the glass manufacturers made an attempt to organize themselves into an All India Glass Manufacturers' Association, but it did not make much headway. The organizational defects of struggling industry can be removed to a considerable extent under conditions of economic stability.

To sum up, the main causes of this stagnation may be ascribed to (1) unfavourable economic conditions, (2) lack of internal organization, (3) low technical standard, and (4) absence of a Central Institution.

Some Post-War Aspects

Case for Protection.—The foregoing considerations will inevitably lead one to infer that glass industry now occupies a key position ; it is not a war time industry. In fact, provided circumstances remain favourable it has a great potentiality and, as discussed in the last issue, it is expected to play a far more important rôle in the post-war period. The causes of its unsatisfactory position have already been analyzed. The Tariff Board in 1932 had established that the industry had suffered from unfair foreign competition, specially the Japanese, and needed some protection. But the conditions of 1932 have now changed and need reconsideration. The recent assurances repeatedly given by the Hon'ble Sir Ardeshir Dalal with his characteristic emphasis that the policy of discriminating protection to deserving industries will be liberalized have, therefore, aroused great confidence in the mind of glass manufacturers who with the end of war in sight had again begun to be obsessed with the repetition of past experience.

Critics of the Government generally argue that protection was not given to the glass industry in order to safeguard the British interests, and the Government do not generally encourage Indian industries. In the case of glass industry, this view does not seem to be borne out by facts, since most of the imports of glassware into India have been from countries other than the U. K. ; the major portion coming from Japan. (Table I).

TABLE I*

Percentage of Value of each kind of Glassware imported from different Countries in India during 1938-39.

	Czecho-slovakia	Japan. 54·1	Italy.	Ger-many.	British Empire.	U.S.A.	Austria.	Belgium.	Other
Bangles	39·1	54·1	...	1·8	2·1	...	...	...	2·9
Beads and false pearls	32·8	36·3	20·1	6·7	...	...	2·1	...	2·0
Bottles-Sodawater bottles	...	64·4	...	20·7	18·0	...	...	...	0·9
Other bottles and phials	5·1	64·0	...	20·3	6·6	...	...	...	4·0
Lampware	15·5	13·7	...	48·9	8·1	4·5	7·4	...	1·9
Scientific glassware	...	20·7	...	57·0	18·6	...	...	...	3·7
Sheet and plate	2·9	30·2	...	12·3	12·2	...	...	40·6	1·8
Tableware	5·8	72·2	...	6·8	10·3	...	...	...	4·9
Other kinds	4·8	52·1	2·5	10·9	16·0	...	...	...	...

* Science and Culture, 9, 286, 1944.

These figures clearly show that the rejection of Tariff Board's proposals did not help the British Glass Industry, but incidentally assisted Japan to capture a good market in India. It was probably the insistence on technicalities (the chief argument being that soda ash, the principal raw material being still an imported product, the industry did not satisfy the conditions of Fiscal Commission) that a well presented case was rejected.

One may argue that after the grant of protection, the industry being comparatively free from foreign competition will neglect the interests of the consumers and no attempt will be made to improve methods of production and cheapen the goods. This is rather an extreme view. After all no industry, howsoever, patriotic the Government may be, can be given a life long protection and the grant of protection for a certain period amounts to giving a chance to the industry to prepare itself to ultimately withstand unfair foreign competition. Glass industry, as recommended by the Tariff Board presided over by an eminent economist like Dr John Matthai, deserves such a consideration.

Development of the Industry on Modern Lines. But protection alone is not the panacea for all evils. The industry will have to be organized on modern lines. The technical standard which is one of the contributory factors to cheap and quality production will have to be raised. The present position and size of many of the factories is not very conducive to many of the technological developments. After the last Great War, glass has become a highly technical industry and the Tariff Board was right in stressing this point. Unless the size and working of the factories can become of the economic standard, it is difficult to see how the aid of modern technological knowledge can be brought to bear upon the development and progress of the industry. In the absence of these conditions it appears even futile to lay much stress on the high standard of training or employment of foreign experts. The field for the display of their talents is a prerequisite to their employment and must naturally come first

The quality of the products has to be improved and the fears of the consumers that in the absence of competition the industry shows little anxiety for quality may not be altogether unfounded. During such times when every article is saleable, the producer is really on test, since in normal periods he will have to appeal to the consumer for patronage to purchase his goods. No doubt, the scarcity of some essential materials has contributed to this deterioration in quality, but the existence of free and sufficiently large market has also had its effect and in the absence of technical guidance, small units hurriedly established have adopted wasteful methods of production and consequently the quality of products is low. Maintenance of quality and raising standards of production will always be the responsibility of the industry because no State aid, howsoever large, can help an industry establish itself, unless it can also call quality of its products to its aid.

Central Institute.—But to organize the industry on modern lines, the existence and association of a well equipped and staffed central technical institute is very essential. Such institutions have been of immense help in the survey of raw materials, standardization of goods, dissemination of information, training of workers etc., all of which have contributed to the development of the industry. The absence of a technological institution and of trained workers constituting a bottleneck has been emphasized ever since the Industrial Commission (1918). The Tariff Board, in fact, proposed the establishment of a technological institution for glass as a condition to the grant of protection. At this stage of technological advancement in industries, one need not stress the importance of the application of scientific knowledge to industrial production and the part played by institutions in this development. It is, therefore, a happy augury that the Council of Scientific and Industrial Research is now actually engaged in the establishment of a Central Glass and Ceramic Research Institute at Calcutta. But the condition of the industry will have to be improved so as to be in a position to absorb and utilize the researches carried out at the Institute. The development and utility of the Institute are very largely dependent upon and very intimately connected with the prosperity and progress of the industry. For the Institute to be of real service, there should not only be intimate but sympathetic contact between the Institute and the industry. It is hoped that the industry will take an active interest in its development and make liberal contribution to the establishment of the Institution which is expected to be something like a hospital to ensure its welfare.

Technical Training.—The paucity of trained men in this country has long been recognized as one of the contributory factors for stagnation in this industry. The first rectification of this defect, as already mentioned, came through the efforts of the Paisa Fund Glass Training Centre at Talegaon. In 1937 it was the Benares Hindu University which took initiative in providing facilities for training in glass technology on more modern lines and, although the standards may not fully be comparable to that attained in foreign countries, partly due to lack of funds, the progress made during the short period of about seven years has been quite substantial. Its graduates are finding increasing employment in factories and some of them are now holding responsible positions. It is necessary that in post-war period when much emphasis will be laid on techni-

cal training, the facilities of this institution should be increased by suitable contributions. It will not be too much to expect the industry to which its services are of immediate assistance to come forward with liberal donations. It is necessary, however, that such departments should be in close contact with the industry ; may be this much needed contact has not so far been achieved. In spite of there being a Central Institute providing facilities for higher training and research, the important function of such teaching departments cannot be overemphasized and experience shows that it can best be fulfilled in a university. Along with the training of technologists, the training of operatives is equally important. With the exception of what was achieved at the Paisa Fund Glass Training Centre, not much organized attempt has been made in this direction and the feelings of individualism have been partly responsible for it. The recent establishment of an Operative Training School (at Bahjoi) by Mr. Varshney is indeed a very timely step. It is believed that this step which is just another contribution of this pioneer will be augmented to the benefit of the industry.

But in a country which is yet to develop the now well established and standardized processes for the manufacture of several new type of glass articles such as optical glass, chemical resistant glass, toughened glass, plate glass etc., the training of Indian personnel in other countries and the importing of foreign technicians for a temporary period will assume more than usual importance. Although Indians have received training in foreign countries and foreign technicians have been employed in India, the need of a co-ordinated plan as an integral part of post-war developments has never been felt so forcefully as at present and the industry in general is most fortunate for the keen interest shown in this regard by the Hon'ble Sir Ardeshir Dalal.

Since this subject is to actively engage the attention of the Government, senior scientists and industrialists of the country, it will perhaps be premature rather imprudent on the part of the present writer to say much about it. One of the main defects of the system of sending Indian men abroad has been that the persons were sent for training without previously making suitable arrangements for their employment after their return. The results have, in some cases, been rather discouraging, and there are instances when people had to earn their livelihood in professions completely different from their training. The expenditure on this training, therefore, if considered objectively, has amounted to national waste. There is no doubt that in drawing up a scheme of foreign training which is expected to be quite gigantic, full advantage will be taken of this experience. Such training should be given in subjects or processes for which there is arrangement with the industry to absorb them immediately on their return, and before selecting suitable candidates for training, requirements of the industry should be first studied. In fact, during their training the trainees should definitely work with the aim of developing these processes in the country. With regard to the subjects for training with a view to developing new processes in the country consideration should be given to the fact that a mere mention of glass, porcelain etc. may lead to confusion, since even the production of one article involves several operations and the co-ordinated services of different type of technicians. To lay stress on only one aspect or to expect one person to be an omnibus expert will be an error, and some failures in the past, either with Indian trained men or with foreign technicians, may be traced to this mistake.

The training of personnel will also involve the question of financial adjustments with the firms where the trainees will work, or whose experts or technical knowledge may have to be imported into the country. A pointed reference to this aspect was recently made by Sir S. S. Bhatnagar in his address to the Institution of Engineers (India). It may be a comparatively simple affair to arrange the training of personnel in general scientific subjects, but training in special processes will certainly involve these complications. This question, therefore, is neither purely scientific nor entirely commercial. What can be achieved by close co-operation has been amply demonstrated by Canada. As late as 1940, she did not produce even a single piece of optical glass, but has now succeeded in producing various types of optical glasses and instruments within a year. In this connection, the following extracts from an article by Dr W. M. Hampton[6] are worthy of note :

"A Government company, Research Enterprises Limited, was formed during 1940 to erect a factory in Toronto for the manufacture of various instruments, and in some cases the raw materials which were necessary for them. When it was decided, about October 1940, to commence the manufacture of optical glass there, Colonel W. E. Phillips, the President of the company, approached Chance Brothers & Co., Ltd., through the Canadian and British Governments, with the suggestion of co-operation. As a result of that approach I visited Toronto in November 1940 in order to ensure the most rapid development of the new undertaking. The result was that an arrangement was reached whereby the fullest information concerning the manufacturing technique was transferred to the Canadian factory, and certain physicists from Canada came to England and were trained in the art and technique of making optical glass. These physicists remained at our works for some two to three months and were attached to our own personnel, so that they had the fullest opportunity of learning all that we could teach them about the manufacture of optical glass. A number of other people were recruited in this country, some from the Canadian Forces here and some from our

[6] W. M. Hampton—*Proceedings of the Physical Society*, Vol. 54, Part 5, 1st September, 1942, No. 305. Pages 392 to 393.

own staff, and were given a special intensive course before being sent to Canada for starting up the new process. Further, when manufacture began, one of our technicians went to Canada for some months in order to assist in overcoming the initial difficulties, so that the closest co-operation was maintained and is still being maintained. When it is realized that in November 1940 the optical-glass plant consisted of merely the walls of what was to be a factory, and that the first melting was successfully made in June 1941, and that by the end of 1941 a considerable number of meltings of first-quality glass had been made, it will be realized that, owing very largely to the enthusiasiasm and drive of the Canadian executives, a very remarkable result has been achieved. There has throughout been the closest co-operation between the Canadians and ourselves, and it can be said that there has been no serious hold-up or difficulty in transferring the manufacture from this country to that.

"The factory occupies about 16 acres, but only a portion of this is devoted to glass manufacture. The pots used are being made by a casting process which is essentially that employed in the Bureau of Standards, namely, the slip-cast method, by which clay treated with a small amount of alkali to give a fluid suspension is poured into a plaster mould. This method, which is well known, has the advantage of being more rapid than the old hand method, and also provides a pot which is considerably drier than that by the old process, and it therefore dries in a relatively short time. When required for use, the pot is preheated in one of the batch of pot arches, then transferred to the gas-fired regenerative furnaces and filled with the appropriate batch. Because of the relatively small tonnage employed in an optical glass factory, a mechanical system of weighing is uneconomic, and, therefore, weighing and mixing are done by hand. The scoops and pans used for handling the batch are of stainless steel. All the sand before being used is run through a magnetic separator to avoid any risk of extraneous contamination. The city gas-fired furnaces are of the regenerative type and were built by American companies to R.F.L. designs. The empty pots are placed in the furnace by a hydraulic pot carriage, which goes under the name of "Winnie". The rest of the procedure for making, cutting up, moulding, examining, and so on, is an exact copy of that employed at our works in this country, and, in fact, the Canadian factory may be said to be a modernized version of our works. The differences are merely those which are possible because of the existence of an entirely new site and of the possibility of organization from the commencement. The types of glass being made at present are about six, which are the main types in general use for optical instruments. The clays available in Canada have not so far been found appropriate for the more extreme types of glass, but the manufacture of these is visualized, and the continuing co-operation between Canada and Britain will, when necessary, ensure the provision of pots of the appropriate resistance to attack to enable all types of glass to be made.

"Since the Canadian factory makes not only glass but also instruments, R.F.L.'s customer is in effect itself, whereas in this country the grinding and polishing work is done by separate firms, a method which has both advantages and disadvantages.

In considering the rapidity with which this works was put in hand, it should be remembered that at the time it was being built there was no lighting restriction, so that the factory was built continuously day and night, and there was at that time practically no restriction on the quantity of labour available. These comments are not intended to detract in any way from the achievement of Colonel Phillips and his colleagues, and I can only add that collaboration with them has been simple and complete."[4]

Internal Organization.—Due to severe internal competition the feelings of individualism and suspicion have been quite common in the glass industry. After a period of hard struggle, it is now enjoying a period of prosperity and is comparatively free from the effects of external competition. But apart from expanding production with a view to capturing markets, little has been achieved by way of internal organization and stabilization. The Bengal Glass Manufacturers' Association is a notable example and the attempt has been quite successful. Provincial organizations unless coordinated by a central body are apt to be sometimes detrimental to progress by indulging in rivalries. The organization of the All India Glass Manufacturers' Federation is, therefore, a timely move, and if the enthusiasm continues it is expected to be a very useful organization. The Glass Industry in India comprises within its fold a very important cottage industry, namely, the bangle industry, which has been preserved in this country by the artisans of Firozabad and other places in the face of heavy competition. Although for its materials *i.e.*, the bulk glass, it primarily depends upon modern methods of manufacture, the art of bangle making along with the decorative processes will, for some time to come, remain a cottage industry for the display for individual skill. Any organization of the glass manufacturers will have to protect the interests of this class of workers and create conditions for the employment of better and healthy methods of manufacture. It is hoped that they will not be left out in outhouses like the poor relations of a rich man.

Apart from the industrial organizations ; the influence of technical societies on the phenomenal development of the glass industry has been very fundamental. In England, for instance, the Society of Glass Technology has exercised a very great influence on the progress and internal organization of the industry by way of providing common platform for discussions in an unbiassed atmosphere. It has been a leader in the scientific field and has helped in the establishment of international organizations such as the International Convention on Glass and International Congress. Similarly in the U. S. A., the American Ceramic Society is a very powerful body and is probably the biggest in the world on these subjects. Although these societies are mainly technical in outlook, they differ from the purely scientific bodies by throwing open their membership to professional men, industrialists, artisans etc., and it is probably in this respect that they have played a fundamental rôle.

In India, the Indian Ceramic Society was established about twenty years ago, but since the industry passed almost immediately into a period of depression, the society also could not make much headway. It is time that it should be revitalized and integrated into an effective organization of the industries concerned. The opening of the Indian Section of the Society of Glass Technology is a timely contribution to this end.

State Control.—During war time when the essential aim is somehow to ensure supplies, the establishment of new factories is likely to become rather haphazard, depending more on the war situation, and their unsuitability becomes apparent only in post-war periods. The essentials of location for practically all types of factories are more or less the same ; the predominating factors may be different for different industries. For instance, for glass the nearness of market has been responsible for the success of a large number of factories situated far away from the raw materials and fuels. Some amount of control has to be exercised on the location of factories. The need for such an intervention was felt in the case of the sugar industry when, after the grant of protection, a large number of factories were established in the United Provinces in a small area each competing for the sugar cane grown in the locality thus throwing a great burden on the railways for handling cane for them from long distance. The situation became serious and, in fact, the U. P. Government restricted this uncontrolled growth by a zonal system. Here is an example when uncontrolled development may even offset the benefit of protection and lead to unhealthy rivalries. The State can help to avoid this competition by exercising the necessary control on the location of factories in consultation with the Manufacturers' Organization. Another difection in which State control can be of help is to avoid the growth of a large number of factories attempting to engage in the production of goods of only one type, while there may be enough field for the manufacture of articles not yet manufactured in the country. This should not imply that monopoly should be secured for some particular factories.

These are only some of the aspects with which the future of glass industry in this country if it has to play a rôle discussed in the previous issue, is intimately bound up, and in any scheme of post war plans their consideration is desirable. The condition of the industry is very backward and so the efforts to improve it will have to be concentrated and properly coordinated. The author claims no finality to the examination of these problems and has written these lines in the hope of focussing attention and initiating discussion on the future of glass industry in this country.

A LETTER FROM EINSTEIN

PROF. ALBERT EINSTEIN in accepting the offer of the Bimala Churn Law Gold Medal, made by the Indian Association for the Cultivation of Science, writes to the President and the Secretary of the Association as follows :

January 31, 1915.

Gentlemen,

I accept with great humbleness and gratitude the award of the Bimala Churn Law Gold Medal as a sign of appreciation and sympathy.

May I add the hope that in a not too far future intellectual curiosity and striving for truth will become stronger forces in humanity than political passions.

Yours very sincerely,
A. EINSTEIN

The Institute for Advanced Study,
School of Mathematics,
Princeton, New Jersey,
U. S. A.

Notes and News

FRANKLIN D. ROOSEVELT

PRESIDENT ROOSEVELT has died. It is not easy to accomodate the death of a man who was only the other day one of the world's greatest and most responsible figures to whom millions of men and women looked for the initiation of a brave new world. A great leader of peace as well as of war, he died at the critical moment when the decisive stages of the war are being fought and victory has become only a question of time. With the prospect of peace drawing near, it is a great tragedy to be deprived of his inspiring leadership the world stands so much in need of, as the equally urgent and pressing problems of peace are about to come up for solution.

America's most renowned and popular President after Abraham Lincoln, Franklin Roosevelt's name will go down in history as one of the greatest statesmen of the age. He presided over the affairs of his country during the most critical period of her existence that began with the great economic depression. When Roosevelt came into power in 1933, the U. S. A. presented problems created by a plutocratic democracy *viz.*, those of unfettered individualism and unbriddled capitalism. It was no small task to temper such a society with adequate measures of State control in the teeth of serious opposition from Big Business. His New Deal was a great experiment and a bold attempt at transforming an individualistic society saturated with the free and adventurous spirit of the early colonists into a national State and a political union. It helped America to recover from the serious effects of the depression that threatened to strangle the entire economic life in 1929-1932, and rally all her forces against Axis aggression in 1941.

To us scientists, Roosevelt appeals not so much because of the superb statesmanship with which he handled political and economic issues, but because of his recognition, and sincere conviction in, the application of science as a panacea for many social and economic evils. The Tennessee Valley Authority which he established in 1933 by an Act of the Congress represents the most far-reaching adventure in regional planning outside Russia. The story of the TVA often told through the columns of our journal is a story of harnessing the waters of a capricous river by scientific methods for the development of a prosperous valley, once a useless and unsafe region. To Roosevelt goes the credit for starting a new experiment in regional planning and scientific development and a new form of administrative machinery that can function inspite of party politics. "Many hard lessons", said the president, "have taught us the human waste that results from lack of planning. Here and there a few wise cities and countries have looked ahead and planned. But our Nation has 'just grown'. It is time to extend planning to a wider field, in this instance (*i.e.* TVA) comprehending in one great project many States directly concerned with the basin of one of our greatest rivers." It was at one time widely held that the democratic form of government is not suitable for the planned development of the country. The success of the TVA and of the great constructive measures carried out by the Bureau of Reclamation has unmistakably shown that the democracies can also plan as successfully as the totalitarian States.

With the outbreak of war in Europe in the autumn of 1939, Roosevelt clearly realized that American involvement in it was inevitable despite all efforts to maintain neutrality, and took steps to mobilize the scientific talent and resources of the country. The creation of the National Defence Research Committee in June, 1940, and the Office of Scientific Research and Development in June, 1941 by executive order of the President has been largely responsible for bringing scientific talent to bear on the successful conduct of the war. His Government has been extremely generous in disbursing sums on defence research, which have amounted to several billion dollars.

To be simultaneously a leader of peace as well as of war is a rare phenomenon. His presidency was unquestioned during his eight years of office in peace and remained unchallenged even after Pearl Harbour. His rise to power closely coincides with Hitler's rise in Europe. He weilded enormous power but, unlike the power of the Nazi dictator, it was freely granted to him by the Nation and Congress which could at any moment withhold it from him. Roosevelt has passed away, but he will be remembered as one of the greatest leaders that democracies have ever produced.

PRESIDENT ROOSEVELT'S LETTER TO DR VANNEVAR BUSH

THE following letter which appeared in *Science*, December 15, 1944, was addressed by President Roosevelt to Dr Vannevar Bush, Director, Office of Scientific Research and Development. The Office, it might be recalled, was brought into existence in June 1941 by an executive order of the President to co-ordinate and direct all defence researches. The

letter expresses the President's deep and abiding faith in the methods of science and technology for the creation of conditions essential for 'a fuller and more fruitful life.'

Dear Dr Bush :

The Office of Scientific Research and Development, of which you are the Director, represents a unique experiment of team-work and co-operation in co-ordinating scientific research and in applying existing scientific knowledge to the solution of the technical problems paramount in war. Its work has been conducted in the utmost secrecy and carried on without recognition of any kind ; but its tangible results can be found in the communiques coming in from the battle-fronts all over the world. Some day the full story of its achievements can be told.

There is, however, no reason why the lessons to be found in this experiment cannot be profitably employed in times of peace. The information, the techniques, and the research experience developed by the Office of Scientific Research and Development and by the thousands of scientists in the universities and in private industry, should be used in the days of peace ahead for the improvement of the national health, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living.

It is with that objective in mind that I would like to have your recommendations on the following four major points :

First : What can be done, consistent with military security, and with the prior approval of the military authorities, to make known to the world as soon as possible the contributions which have been made during our war effort to scientific knowledge ?

The diffusion of such knowledge should help us stimulate new enterprises, provide jobs for our returning servicemen and other workers, and make possible great strides for the improvement of the national well-being.

Second : With particular reference to the war of science against disease, what can be done now to organize a program for continuing in the future the work which has been done in medicine and related sciences ?

The fact that the annual deaths in this country from one or two diseases alone are far in excess of the total number of lives lost by us in battle during this war should make us conscious of the duty we owe future generations.

Third : What can the Government do now and in the future to aid research activities by public and private organizations ? The proper roles of public and of private research, and their inter-relation, should be carefully considered.

Fourth : Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war ?

New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life.

I hope that, after such consultation as you may deem advisable with your associates and others, you can let me have your considered judgment on these matters as soon as convenient - reporting on each when you are ready, rather than waiting for completion of your studies in all.

Sincerely yours,
Franklin D. Roosevelt.

NATIONALIZATION OF IMPORTANT INDUSTRIES

The Government of India have at last come forward with something like a statement of their future industrial policy. A recent announcement from New Delhi, wherein the Government have provisionally expressed their intention to nationalize a number of important industries, to look after general industrial development, and to secure necessary measures and controls to regulate balanced and regional development, will stimulate great interest among industrialists, scientists and others deeply concerned with the economic regeneration of India. The fundamental object of industrial development will be, the report adds, to increase national health by the maximum utilization of country's resources in men and material, to secure a high and stable level of employment, and to prepare the country for adequate defence.

With this end in view, the Central Government propose to undertake, in consultation with the Provinces and under provision of the India Act, the development of certain important industries as a Central subject. Such industries include the iron and steel, the manufacture of prime movers, automobiles, tractors and air-craft, ship-building and marine engineering, the manufacture of electrical and heavy machinery and the machine tools, chemical textiles, cement, power alcohol and electric power industries. Ordnance factories, public utilities, and railways which are already very largely State-owned and State-operated will continue to remain so. The bulk generation of electric power will be a State concern as far as possible. Besides, the case of coal is proposed to be examined and dealt with separately. All

other industries will be open to private enterprise, subject to varying degrees of control.

In order to gain experience of the management of industries, the Government have indicated the possibility of certain industries being managed by private agencies or public corporations for a limited period. Ship-building, manufacture of locomotives and boilers and some other key industries may be run by the State as well as by private capitalists.

Apart from direct ownership and management of certain key industries, the Government propose to undertake a co-ordinated development of transport and electric power, an efficient survey of mineral resources, and the promotion of scientific and industrial research and higher technical education. Adequate financial support to research organizations set up by industrial associations has been indicated. Industries will be given facilities in procuring capital goods from abroad and also expert services, and to this effect, organizations will be established in the U. K. and the U. S. A. As further encouragement, the Government will buy the products of Indian industries in preference to those of foreign ones.

Controls will be introduced to secure balanced investment in industry, agriculture and social services. Improved provisions for fair wages, decent conditions of work and living, a reasonable security of tenure, safeguard against excessive profits to private capital, equitable distribution of assets as far as possible, and ensurance of quality in the final products of the industry are contained in the report. Government propose to take power by legislation to license the starting of new factories and the expansion of the existing ones. They are further contemplating to constitute a board to advise the Government in the matter of granting licenses for the industries to be taken over by the Government.

To the list of subjects for Central responsibility, we may add the multi-purpose development of India's water power resources. The difficulties arising out of the division of responsibility in this matter have been stressed in the editorial article of the present issue, and it is imperative that the Central Government should undertake the main responsibility for the development and utilization of water resources. We, however, reserve our comment on the various issues raised by the proposed nationalization of important key industries until we have seen the full text of the proposals not yet to hand.

CENTRAL WATERWAYS, IRRIGATION AND NAVIGATION COMMISSION

THE Government of India have decided, according to a press report, to set up a Central Waterways, Irrigation and Navigation Commission. The object of this Commission would be to plan and co-ordinate the organizations that would examine the potentialities of Indian rivers. It would further co-ordinate the development of rivers passing through more than one Province or State.

The Commission will be able to advise the Central, Provincial and State Governments on waterways, irrigation and navigation problems throughout the country. It will conduct surveys and investigations with a view to securing utilization of India's water resources and press forward schemes for the conservation, control and regulation of water and waterways in consultation with Provincial and State Governments. The Commission will advise the Centre in respect of principles governing water rights, inter-provincial disputes, and on the appropriate basis of agreement between the parties in dispute. It will also advise the Central Government in regard to the settlement of priorities as between various projects.

INDIA'S PETROLEUM RESOURCES

THIS formed the subject of two lectures delivered by Mr D. N. Wadia, Mineral Adviser to the Government of India, Planning and Development Department, on the occasion of the award of Jay Kissen Mukherjee Gold Medal made to him by the Indian Association for the Cultivation of Science. In the beginning, Mr Wadia described the extent of distribution of petroleum belts on the earth's surface. Starting from the Pacific coast of the American continent, belts run through Morocco, Central Europe, Russian Oil fields, Iraq, Iran, Beluchistan, Sind, the Punjab, north-eastern Assam, Burma, Malaya, Sumatra, Java, Borneo, Philippines, Formosa, and terminates in Japan. The petroleum belts correspond to the zones of younger folded mountains (tertiary) on the earth's crust. He pointed out that this folding of mountainous zones was just the cause of petroleum formation, and further these zones supplied the ideal structures for the accumulation and preservation of mineral oil in the accessible layers of the earth's crust.

Discussing about the origin of petroleum, he mentioned that petroleum was formed from the subterranean decomposition of organic matter, mostly by distillation of the protozoa and other animals of that period, and largely also from the vegetable plantation life of the period. Regarding the sites for accumulation of organic sediments in which the oil occurs, the gulfs, estuaries, and deltas along the coasts of the seas of certain geological period when organic matter was abundant are found to have offered conditions favourable for the formation of petroleum. The anticlinal dome structures, he pointed out, are the best and most favourable structures, but a reference to the oil-field structure of the different places of the world will show that the anticlinal

structure is not always present, and other structures exhibiting monoclinal and homoclinal folding are also favourable, provided other conditions of petroliferous pervious beds being capped by impervious beds are satisfied. In such geological structures oil always occurs in the pervious beds (sand-stone, sand etc.) filling the void spaces overlain and underlain by some impervious beds like shales and clays. In the pervious beds again oil which is a liquid hydrocarbon is also associated with gaseous hydrocarbons, and in such structures gas always occurs in the upper portion of the anticlinal crests. He also discussed the complexities in such structures like asymetric anticlines, faulted and disturbed state etc.

He then referred to the problems arising from migration of oil from the place of origin, *i.e.* the source rock, to certain places where suitable reservoir rocks provided more favourable conditions of storage. There are many instances of the escape and loss of the mineral oil from the original reservoir in the strata due to faulting, erosion and truncation of the mother-rock, and from its over-lying strata due to deep weathering and denudation of anticlines etc. Such examples have been quoted from salt-range and other places of the Punjab. Mr Wadia estimated world's total reserve of mineral oils at 65,000 million barrels and world's annual production at 22,00 million barrels. India's reserve is yet difficult to estimate, but as a rough estimate India's annual production may be placed at 83 million gallons, and India's annual consumption at 400 million gallons.

In India there are two important petroliferous belts, namely (*i*) the extension of the Iranian belts to Beluchistan-Punjab, passing through the Potwar-salt range tract, (*ii*) the Arakan-Burma belt beginning from north-east Assam, passing through eastern regions of Assam across the Arakan range along the Irawaddi in Burma and thence, through Arakan coast, extending to Straits-settlements.

Oil exploration in India is yet in the early stage, fitful and defective, although it began in 1800 in Arakan, in 1820 in Burma, and in 1870 in the Punjab. But the history of exploration in India is one of long record of drilling failures and disappointments. Oil-exploration is an extremely expensive and risky enterprise, but intensive geological exploration supplemented by geo-physical prospecting in areas like East-Beluchistan, the N. W. Punjab, foothills zones, the alluvium and sand-covered tracts of the southern Punjab, salt range, Assam etc. may yield encouraging results. Mr Wadia pointed out that the oil-resources of a locality must be based on critical study of geological principles of oil generation, migration, storage and the structure. As an illustration, he referred to his discovery of the Joya-Mair oil-field (Potwar) in 1926, and discussed the geological features that guided him in this discovery. He gave some account of oil fields of India and divided them into three important groups (*i*) the Punjab, (*ii*) Assam, and (*iii*) Burma.

Referring to the future prospect of petroleum in India, he emphasized that search for oil should be confined to regions of lower and middle tertiary rocks, for permo-carboniferous or mesozoic oil is so far unknown in India. He stressed the possibility of concealed oil field in Assam and the Punjab, underneath the alluvium, and of recent formation. The geophysical, gravity, seismic, magnetic, and electrical methods alone can be of service in tracing sub-surface oil fields.

Mr Wadia considers the Potwar area of the N.W. Punjab a more promising area than Sind-Beluchistan. In conclusion, he referred to the two potential petroleum zones in India, (*i*) Palaeogenezone at the foot of the Punjab Himalayas, on the analogy of the Iran-Iraq belt at the foot of the Zagros stage, and (*ii*) the Gulf of Cambay.

UNIVERSITY GRANTS IN GREAT BRITAIN

In a recent statement in the House of Commons, Sir John Anderson, Chancellor of Exchequer, has disclosed, according to a report in *Nature*, that a sum of £5,900,000 would be available as a grant in aid of the universities, colleges, medical schools, and teaching hospitals of Great Britain for the year 1945. The recurrent grant for general university purposes has been strengthened by an addition of £2,000,000 in each of the next two years, which has nearly doubled this grant. Following the recommendations of the Inter-Departmental Committee's report, the Government have made a further grant of £1,000,000 for developments in medical schools, and £500,000 in aid of the teaching hospitals. Further, a grant of £250,000 for capital expenditure has been placed at the disposal of the University Grants Committee. This last sum is intended for expenditure on such items as the erection of new buildings, purchase of sites on which to build new buildings etc. Many universities and colleges are now in need of funds to acquire lands and build houses so that they can offer wider facilities for higher education, now badly needed in Britain. It is apprehended that the grant provided for this purpose will prove insufficient, but the Chancellor has assured the House of the possibility of this grant being increased within the financial year if such need arises.

It is stated that about £1,500,000 from the grant for general university purposes will be immediately required for increase in the salary scales of members of the university staffs. It is realized that the salary scales offered to such members are not comparable with these available in other professions employing

men of the same qualifications. While making these grants, the Government have not attempted to encroach upon the autonomy of the universities by imposing any conditions, however justified.

This increased provision for funds will enable the educational authorities in Britain to strengthen the foundation of education and research. Signs of constructive activity and preparedness for peace are visible in all Government measures. In England, money is flowing from the Treasury in million pounds to ameliorate the teachers' lot. In India, sugar coated words and tall promises of the high officials of New Delhi, broadcast through radio or publicized through other propaganda machinery, are what our benevolent Government can offer to encourage the hard hit and starving teaching profession.

AERONAUTICAL RESEARCH IN BRITAIN

At a recent meeting of the Parliamentary and Scientific Committee, Sir Henry Tizard advocated a block grant from the Government of at least £1,000,000 for aeronautical research on the problems of civil aviation. Construction of aircraft for the fighting services has now engaged all aeronautical research and, as Sir Henry revealed, there is virtually no civil aircraft in Britain today. He urged the creation of a new Aeronautical Research Council under the Lord President of the Council. The Chairman of the said Council should be an experienced industrial engineer and should have executive control. The work of this body, when created, would be directed exclusively to research problems relating to civil aviation.

Sir Henry was not very optimistic about the employment of a large number of civil machines in the post-war years. Internal air service, he said, might be expected to yield a revenue of about £8,000,000, *i.e.* 2·5 per cent of that from the railways, and a force of some 80 aircraft would be sufficient for the service. He further expressed the view that regular and economic trans-Atlantic service would not be possible so long as the planes do not fly about the 40,000 feet level and develop a much higher speed, which can alone be effected through intensive research on the problems of civil aviation.

Close at the heels of Sir Henry's lecture comes the announcement by Sir Stafford Cripps, Minister of Aircraft Production, of a scheme to build a great aviation research centre in Britain, to be financed by the Government. The new station which is expected to secure a level of achievement in civil aviation comparable with that attained by the British Air Research Centre at Royal Aircraft Factory at Hampshire (started in 1910) will be located in the Bedfordshire area chosen after a very careful survey.

NATURAL RESOURCES OF THE ANDHRA AREA

A symposium on the 'Natural Resources of the Andhra Area' was organized under the auspices of the Andhra University at Waltair in 1940, when the Indian Academy of Sciences was holding its sixth annual session. On this occasion, a number of distinguished scientists read papers on the faunal, floral, mineralogical, electrical and chemical resources of the area and discussed the possibilities of future industrial development of this region. The University has now done well to collect these papers and publish them under a single volume which will serve as a highly useful and stimulating record of diverse natural resources on which to work out the plan of post-war industrial development of this area. The sixteen papers included in the volume have dealt with fauna, flora and plant resources, fossil flora, fruits, mineral and metalliferous resources, power resources and hydro-electric schemes, and the resources for organic chemical industries, ceramic industries, wood distillation and power alcohol, dyes and tans, paper, oils, gums, waxes and resins, and paint and varnish industry, of the Andhra area. The delay in the publication of the volume which ought to have appeared earlier, it is explained, has been due to unavoidable war-time limitations.

TECHNICAL WORK AT THE INDIAN WATERWAYS EXPERIMENT STATION, POONA, DURING 1942-43

The Annual Report (Technical) of the work done during the year 1942-43 at the Central Irrigation and Hydrodynamic Research Station, Poona, now renamed as Indian Waterways Experiment Station, together with an index for 1938-42, has just been published by the Government of India (price Rs. 7-8 or 11s. 6d. ; available from the Manager of Publications, Civil Lines, Delhi). This is the sixth annual report of the station since it became a Central Station and contains extracts of papers and detailed description of experiments dealing with a wide variety of problems in connection with rivers and canals in various parts of India. Descriptions are further illustrated by necessary diagrams, maps and photographs and are full of statistical data. The report is intended for use as reference by research workers and officers engaged in Irrigation and Railway Divisional offices and in other river research laboratories which have to deal with similar problems. The Director of the Station, in a letter just circulated, has expressed his willingness to give assistance to those who ask for it without charge provided this does not involve model work, special inspections or the expenditure of a considerable amount of time.

PRINCIPLES OF CEREAL STORAGE

The Government of India have recently issued a publication entitled 'Principles of Cereal Storage'

by E. P. Coyne. This is a timely publication, when the problem of food shortage is so acute and when there is need for saving every seer of grain available in India to-day. The production of food grains in India even in peace times falls far short of the demand that increases every year with the growing population. Increased production either by promoting higher yields from existing areas or by extending the area under cultivation is a prolonged process, and as such the saving of grains during storage has become all the more important. According to an official estimate, 600,000 tons of wheat and rice are annually lost during storage. Damage by rodents alone probably accounts for a million tons of all food grains (cereals, pulses, etc.), with similar amounts lost from insect and moisture damage.

The book deals with the important factors in food conservation, *e.g.* climate and moisture damage, standard types of storage, grading of godowns, and general hygiene. These refer specially to present conditions when large stocks of grain are being held by Provincial and State Governments and when we hear so often of wastage of huge quantities of food grains in Bengal and elsewhere, due to damage caused by defective storage.

Damage by insects is mainly caused by beetles, moths, and mites, and it is estimated that a single pest *Calandra bryzea* (rice weevil) sometimes causes a loss of stored wheat valued at nearly one crore of rupees a year in India alone. Remedial measures by fumigation and its application are discussed in detail.

Methods recommended for the control of both house rats and field rats will be very useful not only to those who have to store in bulk but also to the ordinary householder.

It is gratifying to note that the Directorate of Storage, Government of India, is devising means of application of new and improved control measures in laboratory and practice, collecting information from India and from foreign sources, disseminating the same and co-ordinating the activities throughout India in the interest of grain conservation. It is to be hoped that each of those scientific methods of food storage would receive the closest attention of Central, Provincial and States Governments now that they are the principal custodians of India's food supply.

TRAINING IN DAIRYING AT BANGALORE

With a view to meeting the growing demand from the Provinces and States for trained personnel required for implementing post-war development plans, and for filling up higher posts in Dairy Departments, the Government of India have decided to increase the number of students to be admitted for training at the Imperial Dairy Research Institute, Bangalore, from 30 to 85 with effect from July 1945. The Institute provides three courses of training, *viz.*, (1) a two year course for the Indian Dairy Diploma, (2) a post-graduate course for 15 months, and (3) a short course for three months.

It is now proposed to increase the number of students for the Indian Dairy Diploma course from 20 every alternate year to 25 a year, *i.e.*, (50 students, 25 in the first year and 25 in the second year), for the postgraduate course, from 10 students to 25, and for the short term course, to 30 students a year (*i.e.*, 10 students per course). The total number of students in residence will thus be 85 a year.

For this purpose Government have sanctioned in all Rs. 1,40,500 (Rs. 88,000 non-recurring and Rs. 52,500 recurring).

PALYNOLOGY

Prof. P. B. Sears of Oberlin College, Ohio, Mr A. H. Hyde of the National Museum of Wales, and Mr D. A. Williams of Standough Hospital, Cardiff, suggest the term *palynology* (Greek *paluno* to strew or sprinkle) for the study of pollen and other spores, their dispersal, and applications thereof in the October issue of the bulletin entitled "Pollen Analysis Circular".

In recent years the study of pollen has come much to the fore. Research is now being directed towards fundamental problems relating to the liberation, dispersal and deposition of air-borne pollen. The results will have obvious implications in the field of floral biology and should also be of value to the meteorologist. The pollen analysis of peat has become one of the most important techniques used in the study of post-glacial vegetation. Pollen analysis of coal is an aid for correlating coal-seams. The pollen of insect flowers is receiving attention as a means of determining the sources of samples of honey. All these studies have, up to the present, been referred to under the general heading of pollen analysis. It is hoped that the new word will be commendable.

ANNOUNCEMENT

We have great pleasure in informing the readers of Science and Culture that the National Institute of Sciences of India have made a grant of Rs. 750 out of the Rockefeller Foundation grant to our Association. The grant has been made in two instalments of Rs. 500 and Rs. 250 respectively for the year 1944-45, and we seize this opportunity to express our sincere thanks to the National Institute of Sciences and the Rockefeller Foundation for this generous grant.

SCIENCE IN INDUSTRY

INDUSTRIAL UTILIZATION OF BAGASSE

A SERIES of interesting articles on the industrial utilization of bagasse have appeared in the March 1945 issue of the *Journal of Scientific and Industrial Research*. Bagasse is the residue of sugarcane from which the juice has been extracted by crushing and is the main by-product of the sugar industry. It is now largely used as fuel for steam raising purposes in the sugar industry itself, but it may also serve as an important raw material for economic production of activated carbon, resin and plastics, insulating and pressed boards, wrapping paper and straw board, and may further be used as a cattle feed in mixture with molasses. Problems connected with the industrial utilization and development of bagasse have been variously investigated in the laboratories of the Imperial Institute of Sugar Technology, Cawnpore, the Forest Research Institute, Dehra Dun, and the Council of Scientific and Industrial Research, Delhi, and the articles present a good summary of the work carried on in this country and abroad.

Although bagasse finds its main use as a fuel in the sugar industry, its high water content amounting to about 48 per cent. makes it a very low grade fuel. Its calorific value is only about 4,400 B.T.U., but may be increased to 8,350 B.T.U. for the absolutely dry variety. A pound of coal, on an average, may be taken to be equivalent to 3 lbs. of bagasse in calorific value, and one pound of bagasse can produce, with boilers and furnaces of suitable design, 2½ lbs. of steam. Before use as fuel, it is compressed into bales by hydraulic press. Briquetts of bagasse, formed by the application of pressures of the order of 5,000 lbs. per sq. in., have been successfully tried in Australia. But the most important factor is the way in which it should be burned on account of its very high moisture content. Methods of burning, applicable to other types of fuel, can not be tried in the case of bagasse without appreciable loss of fuel efficiency. Its use as fuel involves the design of special furnaces which are described in an article by K. S. Arnold and D. K. Brahma. The authors hold that high combustion efficiency can be attained even with such poor grade fuel through the use of properly designed and correctly proportioned furnaces.

The high porosity and low ash content of bagasse make it a very suitable, and at the same time cheap, raw material for activated carbon whose industrial uses as decolorizer, deodorizer, purifier, etc. are too well-known to need mention. The Imperial Institute of Sugar Technology first started investigations into the possibility of utilizing bagasse for the production of activated carbon. Of the various methods available for its preparation, the one involving the treatment of the raw material with chemicals followed by carbonization and, in some cases, by further activation by gases has given the most encouraging results. Zinc chloride has proved the most efficient activator. K. S. G. Doss and N. S. Jain who have discussed these methods in a separate article state that carbon obtained from bagasse compares well with the imported variety and can be economically produced in India. According to an estimate quoted by these writers, the cost of manufacturing activated carbon in India amounts to Rs. 640/- per ton and may further be reduced, as improvement in the design of furnace and other equipment takes place.

The paper on 'Bagasse-resin and its Plastics' by Prakash Narayan and S. S. Bhatnagar discusses the possibility of manufacturing resin and plastics from bagasse. The use of ligno-cellulosic waste, such as cane-bagasse, as the raw material in the plastic industry has the great advantage that it is cheap and available in plenty. The authors believe that bagasse will become a potential raw material for plastics, specially in the manufacture of articles in which transparency and colour are unimportant.

Insulating and pressed boards, known under various trade names, are now extensively manufactured from bagasse in the U. S. A. In 1937-38, the Forest Research Institute, Dehra Dun, studied the American methods of producing such boards from bagasse under Indian conditions and obtained encouraging results. Mr S. Chattar Singh who has reported on these investigations at some length states that the Asplund or Defibration process has been found to be very suitable for Indian conditions. Samples of boards prepared in the laboratories of the Institute compared favourably with the foreign-made boards so far as their physical properties such as thermal conductivity, sound absorption coefficients, resistance to moisture and mechanical strength are concerned. The smallest economic unit capable of turning out 1,600 tons or 4,800,000 square feet of boards annually requires a capital expenditure of about Rs. 12 lakhs on peace-time price level. The cost of production of one ton of insulating and pressed boards has been estimated at Rs. 270-8-0. Bagasse indeed constitutes a suitable raw material for the manufacture of wrapping papers and straw board, but in view of its huge requirement for this

purpose, their manufacture from bagasse does not at present appear to be a practical proposition.

Bagasse screenings obtained through the use of 49 and 64 mesh screens may be used as cattle feed. The screenings, although deficient in protein content, contain practically the same amount of carbohydrates as other roughages and are comparable to Timothy hay. Bagasse screenings, in mixture with molasses, another by-product of the sugar industry, are reported to have yielded the best results. Mr H. S. Chaturvedi, in his article on 'Bagasse for Cattle Feeding', explains the value of 'Bago-molasses', consisting of 2 parts of molasses and 1 part of bagasse screenings, as a suitable cattle feed.

The foregoing does not exhaust the list of industrial uses of bagasse. Possibilities of manufacturing cellulose from bagasse have been investigated. Dry distillation of bagasse in Cuba has yielded methyl alcohol and formic and acetic acids, and their commercial production in near future is not beyond the realm of practicability. Composted with press-mud, it has further been applied as a valuable manure. Thus Bagasse offers an excellent example of how a by-product once discarded as an industrial waste may be the starting point of a number of important industries.

GLASS-TO-METAL SEAL

The direct glass-to-metal seal represents a great technical improvement in sealing operations. This new device has been particularly welcomed by the electrical industries where sealing between metal and glass accessories is a regular routine work. The *Review of Scientific Instruments*, November, 1944, reports the successful application by the Sprague Electric Company of this new process of sealing in the manufacture of capacitors and resistors. In the case of capacitors, the usual ceramic terminals are supplanted by glass bushings which are then directly sealed to the metal capacitor containers. The details of the process developed by the Company are not revealed, but it is stated that the metal rings with 'matched' temperature coefficients of expansion, previously in use, are now dispensed with. In the case of resistors, the special glass tube containing the resistance unit is sealed to the metal ends.

The new technique has solved the vexed problem of providing adequate safeguards against leaks and moisture. The direct glass-to-metal seal which results in a solid and integral unit at the place of seal has eliminated such defects characterizing older instruments. The removal of organic bushings and other materials liable to be attacked by fungus has effected a better protection of the component parts. Further such seals have proved highly efficient, both electrically and mechanically. The new process has been satisfactorily applied to any metal including steel, brass and monel metal. The technique has been so perfected that more than 10,000 glass-to-metal seals, it is reported, are now produced each day.

GLASS FIBRES

Fifty years ago, it was a fantastic idea to think of glass fibres that are now being made for the manufacture of textiles, table cloths, neck-ties, and decorative fabrics as common articles of daily use, and of special fabrics for industrial applications. As a material for textiles, glass was always attractive to the technician by reason of its non-inflammability and resistance to the effects of high temperatures, which are rare properties of fibres in common use. The production and perfection of glass fibres to their present stage represent a remarkable achievement of the glass technologists. In *Scientific American*, December, 1944, William H. Page gives an interesting account of the various uses to which glass fibres have been put during recent years.

Edward Libbey, of the Libbey Glass Company, is reported to have first succeeded in drawing coarse glass fibres from the heated ends of glass rods in 1893. Continuous glass fibres are now drawn by allowing molten glass to pass through tiny holes in the base of the melting chamber. The filaments, as they emerge from the holes, are wound on a winder revolving at a high speed. Since filaments emerge at a speed much lower than the speed of revolution of the winder, these are attenuated into fine filaments of diameter considerably smaller than that of the holes. Staple fibres of length varying from 15 to 18 inches are formed by allowing jets of high pressure steam to strike thin streams of glass emerging from the holes and then wound on a revolving drum to form a veil resembling a cobweb. Standard textile machineries with modifications to enable them to handle glass textiles have been used to twist continuous filaments and staple fibres, and very fine glass fibres have been produced in this way. The incredible fineness and tensile strength of such fibres may be reflected from the fact that fibres having a diameter of 23 one-hundred-thousandths of an inch can withstand a tensile strength of more than 250,000 pounds per sq. in. Finer fibres with greater tensile strength have, however, been produced experimentally.

Glass fibres have been used singly and in combination with asbestos fibres, rayon, silk or cotton for various specialized applications. Glass asbestos articles have proved very suitable when resistance to high temperatures and to repeated flexing, high strength, and light weight are important considerations. In combination with rayon, silk, etc., glass fibres have been employed for the manufacture of

neck-ties, scarves, wearing-apparel accessories and various decorative fabrics. The production of such articles for civilian use is now curtailed to make available greater quantities of glass fibres for military use.

Glass fabrics impregnated with suitable varnishes are largely used for the making of insulating tapes, braids and cloths in the electrical industry. Such fabrics, besides being very light, have high electrical resistance and have enabled design engineers to build smaller and lighter motors, transformers and other electro-magnetic machines. Flameproof and moisture-resistant fabrics suitable for use as air-craft battery cover, oil pressure switch diaphragms, air-craft tape for expansion joints of hot air ducts, protective clothing for workers, etc. are now made of glass fibres with a coating of synthetic rubbers.

Glass fibres in combination with a plastic resin have given rise to a new structural material for the construction of load-bearing parts of aeroplanes. The material is light, possesses high structural strength and can be readily fabricated. Layers of glass cloth are impregnated with resin and placed, one on top of another, until a laminate of the desired thickness is built up. Such plastic glass laminates have remarkable tensile, compression and impact strengths and are likely to be used on a large scale in air-craft construction. It is stated that such laminates have tensile strengths varying from 50,000 to 80,000 pounds per sq. in., compression strengths of over 50,000 pounds per sq. in., and impact strengths of over 30 foot-pounds.

An important war application of fibre glass consists in its use as glare shields for magnesium parachute flares of about 1 million candle powers. Such flares are used to illumine the targets before bombing operations.

DESIGN OF ROAD CURVES

The design of road curves has become a subject of considerable interest and experimentation in recent times, for it has been realized that for smooth and good driving a simple circular curve with straight approaches at the ends and following the topographical configuration of the land is not always the best and the most efficient course. In traversing such a straight-circular curve, a driver generally experiences a good deal of lurch which at high speeds may become dangerous for his own as well as the safety of other motorists. To minimize this awkward feeling and give the driver a maximum economy of comfort, an adjusting transitional curve is generally interposed between the circular and the straight course, the nature of this curve being such that its radius or degree of curvature is continually changing with reference to a certain fixed point. Varied mathematical expressions have been obtained for these transitional curves, and among the reports of various investigators, the recent work of Professor Royal-Dawson in this field observes particular mention. He has attacked the problem from both dynamic and psychological view points and has arrived at interesting and useful conclusions. According to him the most conspicuous factor in any road curve is the fixing of a standard unit for the rate of change of centripetal acceleration about which a good deal of uncertainty exists at the present moment. The values of these standard rates of acceleration are classified according to the limiting speeds of vehicles, particular attention being concentrated on the sensation produced by a car heading towards a right-hand turn over a badly designed roundabout at speeds varying from 10 m.p.h. to 15 m.p.h.

From several observations it is found that a converging stream of cars travelling at a speed of 10 m.p.h. round an island 140 ft. in diameter could easily absorb an incoming vehicle of 20 ft. average length and also travelling at the same speed, provided the converging stream under consideration has gaps of 46 ft. in between, which would correspond to a traffic density of 800 vehicles per hour per lane. On working a little further, one can show that a car moving under the above conditions would take only 17 seconds to pass a quarter roundabout and 24½ seconds to pass half the roundabout as measured from the tangential edge in both the cases.

Very few motorists, however, seem to realize this, because actually it is found that the cars which pass roundabouts usually travel at speeds far higher than those considered, without any regard to the danger involved not only to themselves but even to the pedestrians who happen to cross the roads.

The difference in driving a light and a heavy vehicle has been solved by considering two types, one representing a 1 ton car of 8 ft. wheelbase with a locking angle of 30 degrees and a steering-gear ratio of 6 : 1, the other a 10 ton car of 16 ft. wheelbase and a steering-gear ratio of 12 : 1, the locking angle being the same as before. From these considerations, steering is regarded psychologically as a series of jerky hand movements with "rest" periods in between, each stroke or jerk representing a fragmentary transition and each "rest" period a circular arc. It can be shown graphically that a given transition may be followed by a motorist within a fairly wide range of spontaneous hand movements on the steering, and it is then only a routine to ensure that the resultant curve conforms reasonably to the general course of the road. The dynamic aspect is clarified by showing that the inherent physical effort

in steering the heavy type vehicle (10 ton weight), combined with the necessity of turning the steering wheel through an angle four times as large as that required for a light vehicle (1 ton weight) over the same curve, renders it imperative to design road curves conforming to the exacting requirements of heavy class vehicles instead of adopting standards suitable only for light cars, as is very often done in practice.

The tests carried out on wholly circular and wholly transitional layouts have gone to prove that for sharp curves and moderate speeds a transitional curve imposes less physical effort than a circular one. For curves of very large radii and high speeds, however, a different set of dynamic and psychological factors are brought into play so that for a good design of such large curves the value of the unit for the standard rate of change of centripetal acceleration should be lower than for curves designed for moderate speeds, if a reasonable margin of safety has to be ensured. According to Professor Royal-Dawson, the ideal curved road course, when such is within the limits of practical design and construction, is a wholly transitional curve, because psychologically it has a greater speed-potentiality than any combination of a transition and a circular arc, while mathematically such a curve represents the shortest route from amongst the "circular-transition" combinations, (measured from some point on the tangent to the given mid-point) and, therefore, from the commercial user's aspect is the most economical.

S. K. G.

VEGETABLE TANNING MATERIAL IN INDIA

Owing to war, tanners in India are finding it increasingly difficult to obtain sufficient supplies of tanning materials from indigenous sources to meet the growing military and civil requirements. Forest Research Institute, at Dehra Dun, in its leaflet No. 72, gives a complete survey of the vegetable tanning materials found in India. The big industrial concerns only deal with four tanning materials, *viz.* babul bark (*Acacia arabica*), myrobalans (*terminalia chebula*), avaran bark (cassia auriculata) found in abundance in India, and black-wattle bark (*Acacia mollisoima*) which is now being cultivated in South India and is imported from Africa to a large extent. Of the others, the following may be of considerable use to the tanners, *viz.* aoule bark (*Emblica officinalis* syn. *Phyllanthus Emblica*), beleric myrobalans (*Terminalia belerica*), dhowa leaf (*Anogeissus* Sp.), divi-divipode (*Casalpinia coriaria*), gother fruit (*Zizypeus Xylopyeus*) hopea bark (*Hopea Parviflaea*), arjun bark (*Terminalia Arjuna*), karanda leaves (*Carissa* Sp.), mangrove barks (*Cariops* and other Spp.), remuja bark (*Acacia leucophoca*), sain bark (*Terminalia tomentosa*), sal bark (*shorea robusta*), sonari bark (*Cassia fistula*), tenpods (*caesalpinia digyna*).

The leaflet gives a list of plants whose tannin content has been investigated quantitatively, and also those whose tannin content is negligible or not quantitatively determined. The correct Latin names with their synonyms, English names, trade names, and vernacular names are arranged alphabetically. The list also includes the localities, habit and habitat, and part or parts of plants that are supposed to be used in tanning. A bibliography at the end of the pamphlet contains details of each species noted in the leaflet.

AGRICULTURAL DEVELOPMENT AND MINERAL FERTILIZERS IN INDIA

P. E. MEHTA

AGRICULTURE has always been the primary industry of India even from early days. The proportion of population dependent on agriculture has risen from 65% in 1872 to 75% in 1940.

Nine-tenths of the population of the country still continue to live under rural conditions and even the factory labour of the towns as well as the commercial classes continue to retain the connection with the villages from time to time from which they have migrated.

The agricultural production of India was directed during the last hundred years towards the securing of an exportable surplus of raw products, to meet India's obligations resulting from her connection with outside countries and not to meet her own requirements.

The following few examples give an idea as to how the agricultural policy is based not on internal requirements but for outward obligations. India produces 52% of the groundnuts, 95% of jute and 45% of rice of the world ; the first two commodities being mainly exported.

The outbreak of the war in 1939, and later the occupation of Burma by the Japanese brought with it a clearer recognition of the importance of agriculture in India, as the import of rice from Burma was completely cut out.

The term fertilizers includes a number of mineral substances, limestone, marl, gypsum, phosphate of lime, green sand, green manure, guano, kainite (K_2SO_4, $MgSO_4$, $MgCl_2$, $6H_2O$) and nitre (KNO_3, $NaNO_3$, etc.) which are of value for adding to the soil to increase its supply of plant food and also in some cases to correct its physical condition. Some of these have other uses over and above that of fertilizers. The most important raw mineral for fertilizers is phosphate of lime. This occurs as crystalline phosphate of lime or apatite associated with crystalline rock phosphate.

Apatite: $3(Ca_3(PO_4)_2\ Ca(F, Cl)_2$

When pure it contains 90% tricalcium phosphate, 10% calcium fluoride or calcium chloride.

The material entering the trade contains varying quantities of Al and Fe phosphates with earthy impurities including clay, silica, lime etc. Among the most important phosphates are:

Collophane $Ca_3\ (PO_4)_2\ CaCO_3$, Strurite $NH_4(MgPO_4, 6H_2O)$, Wavellite $(4AlPO_4)_2Al(OH)_3\ 9H_2O$, Vivianite $Fe_3\ (PO_4)_2\ 8H_2O$, Staffelite $3Ca_3\ (PO_4)_2\ CaF_2$, $CaCO_3\ H_2O$, Triplite $(Fe, Mn)_3\ (PO_4)_2\ (Fe, Mn)F_2$.

Apatite deposits of economic workability are not very common; the largest deposit being found in European Russia. Minerological studies in recent years with the help of X-rays have shown that its composition is best expressed as $Ca_4(Ca_3F)_2\ (PO_4)_6$. Apatite which is commercially known as rock phosphate is by no means uniform in its occurrence and varies from bed to bed and even in the same bed laterally. It is found in igneous rocks. It may be seen as veins in metamorphic rocks and as a product of replacement in sedimentary rocks.

Fluorapatite when pure contains 55·2% CaO, 41·3% P_2O_5 and 3·7% F. For market purposes the combined alumina and iron content should not ordinarily exceed 2·5%.

The lump phosphate and coarse material of high grade are merely crushed and sized for marketing. The unconsolidated material (matrix or muck) is generally of low grade and requires beneficiation by flotation methods.

Different types of phosphates

Triple super-phosphate.—This is manufactured by mixing the high strength phosphoric acid with raw high grade phosphate dust in mixers. It contains about 45% of available plant food.

Super-phosphate.—Phosphate rock containing 70 to 74% tri-calcium phosphate is finely ground to about 200 mesh sizes. It is well mixed with an equal quantity of sulphuric acid and heated, the product passes through different complicated stages before use. Super-phosphate contains 20 to 22% of available plant food.

An interesting process of making super-phosphate has been developed by the T.U.A. in America. If 0·46 lb. of olivine is fused with 1 lb. of phosphate rock a product results containing 22·8% total P_2O_5 of which 21·4% is a citrate soluble and therefore available for plant food. Thus a product somewhat more concentrated than ordinary super-phosphate can be made by a simple fusion process with no expenditure of sulphuric acid. Another advantage of the olivine phosphate process is the presence in the product of soluble magnesia an additional plant food.

The Singhbhum Dunite (Olivine) belt is very near the Dhalbhum phosphate belt, so the proximity of the raw materials is very advantageous. Due to the great paucity of sulphur in India, any process which does not involve the use of sulphuric acid is of great advantage.

Calcium meta-phosphate.— It is glassy in appearance and contains 60 to 65% P_2O_5, practically all of which is available as plant food in contrast with 20 to 22% available in super-phosphate.

Uses

A very large part of the phosphate production of the world undergoes some treatment before use. The chief use of phosphates is in preparation of fertilizing materials for agriculture, 90 to 95% of the world output going ultimately into agricultural use. Phosphate rock is also the raw material for the manufacture of phosphorus element, phosphoric anhydride (P_2O_5) and phosphoric acid. The chief centres of use of phosphatic rock and fertilizers are Europe, North America and Japan.

In the mineral returns of India the pre-war valuation of apatite from Singhbhum is about Rs. 15/- per ton and that of phosphatic nodules of Trichinopoly containing 55 to 60% tri-calcium phosphate about Rs. 10/- to Rs. 12/- per ton.

Deposits of Apatite in India

The best known occurrence is found in the copper belt of Dhalbhum (East Singhbhum). The mineral occurs as a constituent of lenses of apatite—magnetite–biotite—chlorite rock in the main over thrust zone, intermittently for a distance of 40 miles between Dhatkidih in Seraikela State and Khejurdih in Dhalbhum.

The Tata Iron & Steel Co. has done considerable prospecting near Kudada and adjoining areas but they hold no mining lease.

The percentage of P_2O_5 in the ore varies from 20 to 25 on an average. The ore is amenable to crushing and concentration by magnetic separation

of the magnetite and consequent improvement of grade to 35 per cent of P_2O_5.

The reserves of the ore in this area in three distinct belts taking an average depth of 200 ft. are taken as 700,000 tons. The total output between 1918-38 was 28,000 tons. Mr Murray of Rakha mines holds some leases but no data of the output or the reserves are available.

Near Sitarampur a village 25 miles N. W. of Vizianagram a lens of the rock is estimated to have 5,000 tons of apatite taking average depth of 30 ft.

A typical sample gives the following analysis:

P_2O_5	...	40·50%
CaO	...	53·76%
SiO_2	...	1·52%
F	...	3·47%
Cl	...	0·55%
H_2O	...	0·22%

At Jothwad in Narukot-State, Rewa Kantha Political Agency there are apatite-rich rocks associated with manganiferous rocks.

The mineral occurs as a constituent of apatite—spessartite—pyroxene—quartz rock and apatite—spessartite—piedmontite rock and frequently constitutes upto 30% of the volume of these rocks. No estimates are available.

Phosphate rock and nodules are found in the Trichinopoly district of Madras, South Arcot and Pondicherry, Mussorie in U. P. and Jhelum in Punjab.

Foreign Deposits

The largest known deposits of apatite in the world occurs in Kola peninsula west of White Sea in Russia. The apatite occurs in nepheline rock containing aegirite and magnetite in small quantities. The deposits are about 500 to 600 ft. thick and contain 20 per cent to 35 per cent P_2O_5.

The following gives an idea of the consumption per annum of phosphate rocks in different countries[2] before the present war.

U. S. A. ..	... 3 million tons
U. S. S. R. ..	... 2 (probably) million tons
France ..	... 2 million tons
Italy ..	... ¾ to 1 million tons.
Japan ..	... ¾ to 1 million tons.
Germany ...	... ¾ to 1 million tons.
U. K. ...	... ½ million tons
Spain ...	... ½ million tons
New Zealand	... ½ million tons
Australia ..	... ½ million tons
India ..	... negligible

Basic slag.—The basic slag from the steel furnaces contains phosphorus. As the Indian iron ore is poor in phosphorus compared to foreign, the phosphorus content of the slag averages from 3 to 5% which is uneconomical for commercial use as a fertilizer, but by amelioration with apatite a profitable fertilizer might be produced.

Potash in Flue-dust of Blast furnaces.—The flue-dust from blast furnaces contains a certain amount of potash which may be used as a fertilizer. The quantity available is very little and still will have to be used as such; the concentration of the potash in the dust being both difficult and uneconomical.

In 1913, W. A. A. Christie investigated the salt range occurrences and in the Mayo mines alone 21 places were found in which potassium bearing minerals occurred. The percentage of potash varied from 6·8 to 14·4% on an average. In Nurpur mines where the percentage of potash is 13·6 the mineral kainite was recognised.

Bone and bone-meal.—The total tonnage about 100,000 tons[3] is not adequate compared to the requirement of the country and most of it is exported to foreign countries in the raw state. Recently a company named Malabar Fertilizers Ltd., has started making bone-meals in Travancore State with a daily output of 20 tons.

Feldspars.—The potash feldspars orthoclase and microcline, whose composition is expressed by the formula K Al Si_3O_8, contains as expressed in percentages the following:

Al_2O_3	...	18·4%
SiO_2	...	64·7%
K_2O	...	16·9%

Feldspars are widely distributed in many igneous and metamorphic rocks but in most cases they are so intimately mixed with other minerals, that their extraction is not commercially practicable, and it is only when they are found in pegmatites that they are worked.

The possibility of using feldspars as a fertilizer because of its potash contents has been suggested but no commercially practicable means of extracting the desired element has as yet been found.

Prospects

In view of 75% of the population of India depending on agriculture the resources of phosphate rock seem to be poor from our present knowledge. The existing deposits must be proved and intense prospecting work done for finding out new deposits. Methods of concentration of P_2O_5 must be tried in laboratories with maximum recovery. Methods of separating K_2O from the feldspars must be found out. Moves are afoot in establishing fertilizer industries in Travancore by the State authorities and by the Imperial Chemical Industries near Dhanbad in conjunction with the Bihar Government. The salts contemplated for production will mainly be of sodium and ammonium. The problem of the utilization of Indian rock phosphate demands more research than it appears yet to have received.

The imperative necessity of establishing fertilizer industries all over the country can be seen from the position of the acreage under tilling in British India.

DISTRIBUTIONS OF LAND[1] IN BRITISH INDIA
IN MILLION ACRES

	1940-41	in percentage
Forest	68	13·3
Not available for cultivation	87	16·9
Cultivable waste ...	98	19·1
Current fallow ...	45	8·9
Net area sown .	214	41·8
Total ...	512	100·0

It is seen from above that more than half the acreage is not cultivated every year and 30% remains fallow due to lack of proper nourishment to soil.

YIELDS IN LBS. PER ACRE OF SOME CROPS FOR 1938
IN DIFFERENT COUNTRIES

Crop	*Siam*	*Egypt*	*Korea*	*Italy*	*Germany*	*India*
Rice	1,297	3,136	2,464	4,928	- -	834
Wheat ..		1,882		1,434	2,464	728
Cotton ..		440				97

The above table points remarkably the low productivity of land in India as compared to other countries.

It will not be out of place to quote here the observation of Rao Bahadur Bal, Agricultural chemist to the Government of C. P. and Berar. Dr Bal contends "that soils of our province have now reached a stationary rate of fertility at a low yield-level, as a result of cultivation over many centuries without adequate returns or organic matter and phosphate and due to the lack of proper soil management." He therefore suggests that the problem before us is not one of preventing any further deterioration of soil fertility, but is one of finding ways of improving the soils which have more or less reached a minimum stage of fertility.

It is suggested that fertilizer industries should be distributed throughout the country and not centred round certain places to alleviate transport difficulties.

The forest policy of the State should be changed so as to help the ryots to get sufficient timber for fuel so that the uneconomical burning of the manure in place of fuel could be stopped.

The large scale on which we are raising oil-seeds of all kinds suggests vast possibilities of using them in the building up of new industries like paints and varnishes, oils and other lubricating products. India which is at present the importer of the above commodities should be made an exporter and the profits thus accruing from agriculture will go to enrich the people of the country. In the same way other commodities should not be allowed to be exported in the raw state, but efforts made to export them in a manufactured or semi-manufactured state.

In conclusion it must be borne in mind that our fundamental problem is that of adjusting our food resources to the growing population of the country. The prospects of expanding our land resources by bringing uncultivated land under cultivation do not compare well with the rate of increase of our population ; and so the sociological aspect of the problem which is out of scope here has to be considered.

It is not in the larger interest of this country to adhere to a scheme like that to which the Eastern Group Conference would commit it resulting in the exploitation of its agriculture in the interest of the Empire, *viz.*, this country has to export agricultural products in return for manufactured goods and machinery.

The price which India has to be paid for such agricultural expansion in the abandonment of a programme of developing her heavy industries is not worth the trouble.

REFERENCES

[1] Phosphates M. S. Krishnan, G.S.I.
[2] League of Nations Statistical Year Book.
[3] India's Mineral Wealth—J. Coggin Brown.
[4] Our Economic Problem—Wadia & Merchant; Economic Geology—Ries; Economics of Indian Agriculture—R. K. Das; Indian Finance; Report on the improvement of Indian Agriculture—Dr Voelcker; "Studies in Indian Economics" issued by the Office of the Economic Adviser to the Govt. of India—B. G. Ghate.

MEDICINE AND PUBLIC HEALTH

VITAMIN FIGHTS CANCER

A GROUP of research workers of Mount Sinai Hospital have recently reported in *Science*, January 12, 1945, the result of their investigations on the effect of a new member of the vitamin B series on mice cancers. The new vitamin is the folic acid and is also known as the L. casei factor. It was injected in tiny doses into the veins of 89 mice that had developed breast cancers. The injections, given daily, were continued for four to six weeks. The tumours disappeared completely in 38 of the total batch, and 49 of the mice are still living. Only one of the treated mice developed a new tumour. The results were compared with 60 cancerous mice that were not treated with the new vitamin. None were relieved of tumours ; on the contrary, 14 mice developed fresh tumours, and only 20 have survived to this date.

The effect of this new vitamin on cancer in the human beings has not so far been studied. The authors stated that the very limited supply of the vitamin prevented similar experiments with human beings from being undertaken. The L. casei factor whose chemical structure and many other properties are still unknown is at present extracted with difficulty and after costly operations.

The nature of action of this vitamin on cancerous tissue is also not known. The anti-cancer activity of a number of extracts such as material from spleen, yeast and barley, which had been previously noticed, led the present investigators to suspect that some vitamin was responsible for this, and they started investigations on this new vitamin B complex when its discovery was announced.

MEPACRINE *VS.* QUININE

THE stoppage of the supply of quinine from Java, following the Japanese occupation of the island, has led to a wide application of the synthetic anti-malaral drug mepacrine B.P., variously known as 'atebrine' or 'atabrin' and 'quinacrine hydrochloride' of the U. S. Pharmacopoeia, for the control of malaria. Mepacrine, as is well-known, has an acridine nucleus with a long side-chain ending in a substituted amino-group. The fact that the use of mepacrine as a substitute for quinine was forced on the Allied doctors and not resorted to as a matter of choice has given rise to an impression in several quarters that the synthetic drug is inferior to natural quinine. A statement issued by the Medical Research Council's Committee on Malaria (*Brit. Med. Jour.*, Nov. 18, 1944) now places on record that such impressions are largely without foundation. The United States Board for the Co-ordination of Malarial Studies has evaluated the relative merits and demerits of the drugs by wide investigations in civilian, Army and Navy establishments and has concluded that quinine or totaquinine has neither any advantage nor disadvantage compared to mepacrine for routine suppression and treatment of malaria. Mepacrine is an equally reliable and efficacious drug for the control of malaria, and large scale production of quinine or totaquinine, although necessary inasmuch as anti-malarial drugs are not available in sufficient quantity, is not, however, indispensable from any consideration of superiority. The findings of the Medical Research Council's Committee on Malaria have also been similar to those of the U. S. Board. The statement of the Committee further appears to indicate that mepacrine has nothing to fear from quinine even when unlimited supplies of the latter are available and will be used with equal preference for treatment and control of malaria.

DEATHS FROM MALARIA IN BRITISH INDIA

A STATEMENT laid before the Central Assembly by Mr J. D. Tyson, Secretary, Education, Health and Lands, Government of India, shows the number of deaths from malaria in different provinces of British India during the years 1938-43.

In 1938 in British India, 1,577,865 deaths occurred from malaria. Of these, 50 were in North-West Frontier Province, 5,015 in the Punjab, 315 in Delhi, 489 in Orissa, 819,057 in U. P., 1,320 in Bihar, 416,521 in Bengal, 302,250 in C.P., 29,790 in Bombay, 1,686 in Sind, 1,190 in Madras, 181 in Assam, and 1 in Ajmer-Merwara.

In 1939 the total number of deaths reported was 1,411,614. Of these, 30 were in N. W. F. P., 2,477 in the Punjab, 243 in Delhi, 754,068 in U. P., 4,73 in Bihar, 592 in Orissa, 341,321 in Bengal, 267,432 in C. P., 28,833 in Bombay, 1,546 in Sind, 1,394 in Madras, 202 in Assam and 3 in Ajmer-Merwara.

In 1940, 1,393,079 deaths were recorded. Of these, 36 were in N. W. F. P., 3218 in the Punjab, 319 in Delhi, 717,319 in U. P., 3,777 in Bihar, 497 in Orissa, 369,448 in Bengal, 265,265 in C. P., 29,602 in Bombay, 2,106 in Sind, 1,271 in Madras, 107 in Assam and 14 in Ajmer-Merwara.

1,408,068 deaths occurred in 1941. Of these, 93 were in N. W. F. P., 4,366 in the Punjab, 288 in Delhi, 707,456 in U. P., 1,057 in Bihar, 589 in Orissa,

388,381 in Bengal, 269,253 in C. P., 32,099 in Bombay, 2,731 in Sind, 1,335 in Madras, 205 in Assam and 215 in Ajmer-Merwara.

In 1942, 1,513,476 deaths took place. Of these, 07 were in N. W. F. P., 17938 in the Punjab, 1,149 in Delhi, 747,462 in U. P., 378 in Orissa, 426,573 in Bengal, 285,573 in C. P., 28,905 in Bombay, 2,911 in Sind, 1,827 in Madras, 256 in Assam and 436 in Ajmer-Merwara. The figure for Bihar was not available.

In 1943, 1,775,316 deaths occurred from malaria. In N. W. F. P. there were 70 deaths, 6,861 in the Punjab, 952 in Delhi, 800,694 in U. P., 769 in Orissa, 674,330 in Bengal, 254,109 in C. P., 32,819 in Bombay, 2,498 in Sind, 1,787 in Madras, 290 in Assam and 137 in Ajmer-Merwara. The figure for Bihar was also not available in 1943.

The figures of deaths given for Assam, Madras, Ajmer-Merwara, Orissa, Bihar and N. W. F. P. were for municipalities only.

DEXTRAN AS A SUBSTITUTE FOR PLASMA

A. Gronwall and B. Ingelman, of the Institute of Physical Chemistry, University of Uppsala, have investigated the possibility of using dextran as a substitute for plasma in the treatment of shock and have reported their results in *Nature*, January 13, 1945. In the usual treatment for shock, the volume of the circulating blood requires to be increased by the infusion of a liquid which must contain colloids that exert the same colloidal osmotic pressure as the plasma proteins. The colloids must have a molecular size that renders impossible their passage through the walls of the capillaries, should not possess high viscosity, should admit of repeated intravenous injections, and should not remain long in the blood or stored in the organs.

Dextran is a water-soluble high molecular carbohydrate which is formed in solutions of sugar infected with the bacterium *Leuconostoc mesenteroides*. The authors prepared, by well-controlled partial hydrolysis, dextran solutions suitable for infusion. By experiments with dogs, they established that the concentration of dextran in the blood fell to zero in the course of 3 to 4 days. No storage of dextran in the organs could be detected even after repeated large infusions. This, the author explains, is probably due to its decomposition into glucose and relatively low molecular fragments that can easily pass the kidney filter.

In shocks from bleeding, and histamine shock developed artificially in rabbits and cats, they have obtained rapid and lasting effects on the blood pressure, heart action and respiration. Clinical investigations prompted by these initial successes with animal experiments have indicated that dextran is better suited than gum arabic, pectin or polyvinyl pyrrolidone as a plasma substitute.

PROCESSED SOYA BEAN IN BALANCING INDIAN DIETS

D. K. CHATTERJEE

(*Continued from the last issue*)

Treatment of Soya Bean and Improvement of Digestibility

Theoretically, diketopiperazines are anhydrydes produced by elimination of water during condensation. Simple methods of hydration were unsuited in this case as they affected the quality of protein. Sometimes it rendered the protein of soya bean completely useless as a nutritional factor in diet. So in practice, we found out our own method by which these diketopiperazine rings were eliminated and whereby the bulk of the amino-acids was found linked in the old polypeptide way of linkage. Side chain condensations and cyclic formations were controlled as far as possible. The entire protein was homogeneous in structure and quality.

This new soya bean protein with modified structure neither resisted proteolytic digestion nor proved degraded nutritionally. The previous specific reactions indicating diketopiperazine rings were mostly absent.

The chemical treatment mentioned above plus autoclaving with 15 lbs. of pressure per sq. inch for 5 minutes and then blowing out the steam succeeded in liberating the soya protein from the cellulose envelope.

It was also found that during these experiments parts of the cellulose were converted into oxy and hydroxy cellulose.

Experiments on Digestion.—While studying the digestion of soya protein, we took up a comparative study of the digestion of protein from different sources. In our experiments, amino-acids were accepted as the digestible form of protein hydrolysis products, and accordingly the liberation of amino-

acids was measured. In these experiments, conversion of the proteins into amino-acids was taken as the index of digestibility. The degree of conversion was computed by a rate of increase in acidity. Sorensen's formal titration method was applied for the measurement of the increase in acidity. A comparative study of digestibility was made after experiments with (1) Raw soya bean powder, (2) Treated soya bean powder, (3) Goat's meat, (4) Pork, (5) Cow's milk.

Hydrolysis of all the five materials was conducted under similar conditions. The hydrolysis was done on water baths and the temperature of the hydrolysate was kept within 57°C. in the beginning but raised to 70° for the last one and half hours. *p*H was kept between 5 and 5·4. Activated papain was used as the proteolytic enzyme. The activation of papain by hydrogen sulphide was necessary for arriving at the amino-acid stage of the hydrolyzed. The amount of papain added to each of the hydrolysates was always the same but it was introduced by

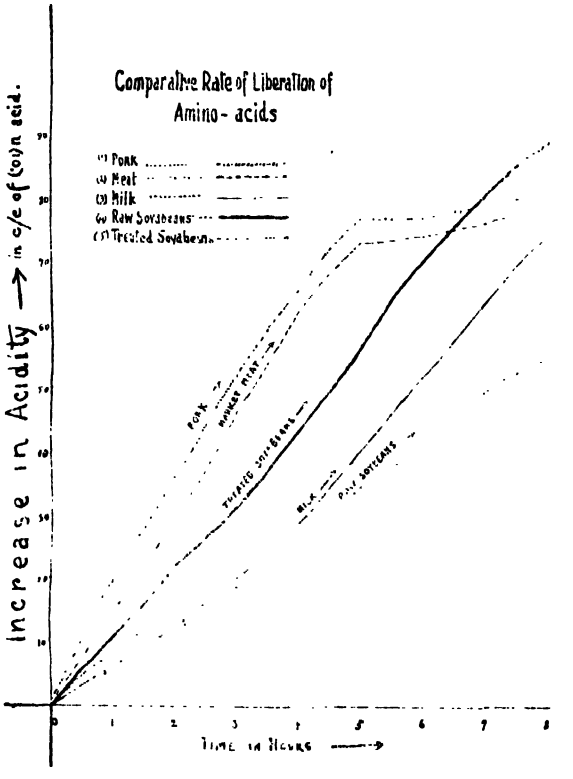


FIG. 1.

instalments of small quantities. Equal quantities of hydrolysates were filtered before titration and phenolphthalein was always used as indicator. Only in the later stage of pork and meat hydrolysis, the hydrolysate was assuming brownish colour, but this was decolourized by precipitation with silver chloride as per instructions of Sorensen ; Jessen and Hansen.

The results obtained have been drawn on the graph : (Fig. 1). These indicate different rates of increase in acidity resulting from the liberation of free carboxyl groups of amino-acids. These amino-acids are in a digestible form. So their increase corresponds to the increase in the rate of digestion.

In case of meat and pork the rate of increase in acidity was very rapid for the first five hours, but after that the increase was extremely slow. But in other cases, no such sudden rise was observed the increase was very regular. At the end of 8 hours, treated soya bean showed the maximum increase. This shows that at the end of 8 hours, treated soya bean has the maximum digestibility.

A biological experiment with treated soya bean flour on rats showed that after continual feeding for 7 days, all the rats increased in weight, without any deterioration in their general condition. The feeding was continued for over two months and the progress observed was proportionate and satisfactory as during the first 7 days of the experiment. The feeding experiments were started after a starvation of 24 hours. These rats were kept under the following conditions :—

1. Each of these rats was separately examined for its general condition—both at the beginning of our experiments and at their conclusion.
2. No other food except treated soya bean flour was supplied to them during the period of experiments. (By treated soya bean flour we mean a powder in which diketopiperazine rings were converted and the cellulose envelope was loosened by chemical treatment).
3. Only fresh water was given as drink.

Through our experiments we observed :—

1. At the end, the quantity of treated soya bean flour taken by these rats gradually became much less than what was taken at the beginning, just after starvation. But this did not seem to affect the general health or outward appearance of the rat in any way. In fact, they were more playful and glossy and their body weight also increased.
2. There was no evidence of any vitamin deficiency after this treatment.
3. The quantity of faeces increased in direct proportion to the quantity of soya flour eaten.
4. The nature of faeces was not changed but they were comparatively soft.

The following table shows the details of our experiments. To show the rate of the loss in weight and subsequent recovery, records of the body weight were made before a starvation of 24 hours:—

The graph and the table support our statement that the actual removal of diketopiperazine rings of linkage and liberation of protein from its first cellulose grip improves the digestibility of soya bean protein to a great extent.

Animal No.	Date	Body wt. of the Rats	Quantity of Treated Soya-bean eaten	Nitrogen in grammes in Food (Intake N)	Nitrogen in grammes in Faeces (Excretion N)	Nitrogen Retained	
						in grammes	in per cent
I	1st Day	9½ oz.	0	0	0·17	—	—
	1st Week	7½ oz.	3 oz.	5·07	0·254	4·816	95
	2nd Week	9 oz.	5 oz.	8·8	0·88	7·92	90
	3rd Week	9½ oz.	2 oz.	3·45	0·30	3·15	93
	4th Week	9½ oz.	2 oz.	3·45	0·35	3·10	90
	5th Week	9¾ oz.	2½ oz.	4·31	0·52	3·79	85
	6th Week	10 oz.	2 oz.	3·45	0·36	3·09	89
II	1st Day	9 oz.	nil	nil	0·186	—	—
	1st Week	7½ oz.	5 oz.	8·8	0·88	7·92	90
	2nd Week	8 oz.	5 oz.	8·8	0·66	8·14	93
	3rd Week	8 oz.	2 oz.	3·45	0·30	3·15	93
	4th Week	8½ oz.	2 oz.	3·45	0·40	3·05	88
	5th Week	9 oz.	3 oz.	5·18	0·60	4·58	88
	6th Week	9½ oz.	2½ oz.	4·31	0·30	4·01	93
III	1st Day	8 oz.	nil	nil	0·15	nil	nil
	1st Week	6½ oz.	3 oz.	5·18	0·65	4·53	80
	2nd Week	7¼ oz.	2½ oz.	4·31	0·65	3·66	85
	3rd Week	7½ oz.	2 oz.	3·45	0·25	3·20	92
	4th Week	8 oz	2½ oz.	4·31	0·45	3·86	90
	5th Week	8¼ oz.	2½ oz.	4·31	0·25	4·06	94
	6th Week	8¾ oz.	2 oz.	3·45	0·40	3·15	90

The bitter taste and disagreeable odour due to the presence of some volatile ketones and aldehydes may be improved by distilling them off under steam. The steam treatment also improves the keeping quality by rendering the original enzyme inactive.

Fat (17 per cent).—The Indian soya beans, with which we worked in our laboratory, have an unusual fat content ranging from 15 to 20 per cent. The darker coloured beans contain a little more oil than the lighter coloured ones.

The soya bean oil consists almost entirely of neutral triglycerides. After saponification about 9 to 9½ per cent of pure glycerine was obtained. Indian soya bean contained more than 1·7 per cent of unsaponifiable matters. Upon slow cooling at about 10°C. the oil loses uniformity and separates out into two fractions; the solid fraction settled in the bottom of the vessel.

The oil when frozen out gives about 14 per cent of solidifying glycerides and 86 per cent of non-solidifying glycerides.

The average characteristics of soya bean oil can be summarized as:

1.	Specific Gravity	0·918
2.	Saponification value	189·45
3.	Iodine value	127·60
4.	Acid value	0·30

The colour immediately after extraction is pale yellow, but when the moisture content exceeds 4 per cent, the colour becomes darker. On the other hand, when on storage, phosphatides separate out, the colour becomes lighter. If sufficient time is not allowed for the separation of "foots", the oil appears to be dark and cloudy.

On storage, the acidity increases and this is due to the fat-splitting process in the oil. On storage we also marked changes in specific gravity, saponification value and iodine value.

The composition of a sample of soya bean oil, extracted from the Sikkim variety of "mammoth yellow large" seed shows:—

Linolic Acid	App. 50%
Oleic Acid	,, 29%
Linolinic Acid	,, 2½%
Stearic Acid	,, 3%
Palmatic Acid	,, 8%

Also traces of Arachic acid was obtained.

The importance of soya bean oil as a remarkably nutritional product, centres principally round its high percentage of unsaturated fatty acids and phosphatides. The oil contains about 81 per cent of unsaturated fatty acids which renders it highly digestible. Munk and his colleagues have shown that under conditions when 9 to 14 per cent of tristearin is assimilated, the corresponding figure of triolein or tribinolin is 98 per cent. Soya bean oil containing (1) Phospholipins, as cephalin and lecithin—2·5 per cent., (2) Non-saturated fatty acids—81, (3) Sterol substances which are related to Vit. D and both male and female gonadic hormones, (4) Carotene (Pro Vitamin A)—about 12,000 U.S.P. units per oz., (5) Other undetermined and undefined units of vitamins B, D, E, F and K should not fail to fulfil the most rigorous demands of the nutritional experts. The above nutritional substances were identified from oils extracted from processed beans.

On refining the oil, lecithin is completely lost, unsaturated fatty acids are almost precipitated by alkali and along with them go out the vitamins, sterols, and other remedial and nutritional materials.

Phosphatides (3·00 *per cent*).—Phosphatides exist in soya beans in two different states. As free phosphatides, they are present in the oil droplets of soya bean cotyledons and the palisade and the aleuron layer and in bound state it exists as protein phosphatide compound. The free phosphatide which forms only a small part of the total phosphatide can be easily extracted by ethyl alcohol (29 per cent). This is always less than 1 per cent. We formed wrong impressions, in our earlier estimations and were inclined to declare this quantity of phosphatide to be the only quantity present in Indian beans. But when heat was applied during extraction or extraction was made with slightly alkaline solvents the percentage of phosphatide increased. The extraction of phosphatides also differed in proportion to the amount of moisture contained in the seeds. For an excellent extraction, the optimum moisture content should be between 7 per cent to 12 per cent. The extraction of phosphatides from dry beans is always less efficient than phosphatides obtained from slightly moist ones. This phenomenon has been explained as the result of the influence of moisture in deranging the existing bonds of the "bound" phosphatides. The usual time taken for the extraction of soya bean oil in laboratory Soxhlet does not exceed one and half hours, during which time about 12 syphonings are completed, but for the extraction of phosphatides an extra four hours was usually required.

In course of experments of extraction of soya bean phosphatides with different solvents, we found that though hot ethyl alcohol proved to be the best solvent for phosphatides, carbon tetrachloride and ethyl ether were better for solvents for extraction of oil.

Though various recommended methods were tried with single and mixed solvents, our best results were obtained in the following way:

Ethyl Alcohol 95 per cent was used, and the temperature of the extracting solvent was raised to 75°C. The processed soya bean samples were ground to 50 mesh fineness. For each gramme of powder, about 160 c.c. of solvent was used.

After extraction, the liquor obtained was cooled to 20°C. when the oil and alcohol separated out into two layers, the upper layer being an alcoholic solution of phosphatides and their carbohydrate compounds, while the lower layer contained mostly oils. The upper layer was treated with calcium chloride to give a satisfactory separation by coagulation of the phosphatides and carbohydrates from alcoholic extracts. In one of his very recent publications, Horvath pointed out that "Soya bean lecithin was bound to a carbohydrate which is only partially removed by organic solvents". We found that it also contained nitrogenous matters of various nature.

The phosphatides of soya bean are mainly lecithin and cephalin. They were fractioned into (*a*) fraction insoluble in cold ethyl alcohol, which was found to contain more than 50 per cent cephalin, (*b*) fraction soluble in cold ethyl alcohol, which was found to contain lecithin in combination with carbohydrates.

Soya bean lecithin was mostly found in bound state. So it should be extracted by ether while ethyl alcohol could not extract it entirely. A part of the lecithin was found to exist in firm chemical combinations with a carbohydrate of di- or polysaccharide type. Before removing the lecithin, it was necessary to boil the carbohydrate-lecithin compound with a solution of 5 per cent H_2SO_4 for at least two and half hours.

The pure soya bean lecithin has the usual physical properties of animal lecithin but it is more inclined to darken through oxidation, and some of its salts of heavy metals behave differently from corresponding salts of animal lecithin.

The cephalin content in soya bean oil is usually more in quantity than lecithin. Soya bean cephalin separates from the lecithin on their difference in solubility in cold ethyl alcohol. This method of separation is often very troublesome, as the presence of lecithin in the fraction partly protects cephalin from being precipitated.

Cephalin obtained from soya bean as colourless solid body shows little or no difference with that isolated from animal sources.

Vitamins.--In their publication, Piper and Morse writes: "It is one of the few plant seeds that contain both of the vitamins necessary to life in higher animals including man". Daniels and Nichols (1917) studied the vitamin content in a qualitative way, and they found that a diet containing 60 per cent of soya bean as the only source of vitamins made possible the production and rearing through the suckling periods to successive litters of young rats. In the experiments of Osborne and Mendel (1917B), the result indicated that soya bean contains a sufficient quantity of water soluble vitamins necessary for the promotion of proper growth. During their experiments which lasted 200 days the rats grew normally and no eyesoreness, common to rats on diets lacking sufficient fat and water soluble vitamins was noted. Our experiments also have afforded us an opportunity to carry out researches on the comparative vitamin contents of treated and untreated soya beans. The presence of Vitamin A, B_1 and E was noticed in considerable proportions in raw beans but during chemical treatment for the improvement of digestibility, about 25 per cent of Vitamin B_1 was lost. Vitamins D and K were also present but no correct estimation of the quantity was possible. In diets prepared from raw soya bean, Vitamin C is completely absent. In the processed soya bean, it is possible to add a proportionate quantity of Vitamin B_1 (from Rice Polish) and Vitamin C (from Amla) to render the nutrition more balanced. In one of our feeding experiments, in which we added as much as 15 mgm. of Vitamin C per ounce of powder we found that the results obtained were very satisfactory.

Carbohydrate (10 per cent by difference). In about 20 per cent of the samples received from northern U. P. and Nepal, appreciable quantities of starch were detected. Only on rare occasions the starch percentage was insignificant.

Of the total quantity of carbohydrates, more than 4 per cent dissolved in 95 per cent alcohol did not reduce the Fehling solution immediately, only on boiling with mineral acids, the reduction of the solution was brought about. This particular portion of carbohydrate when treated with nitric acid, yielded acetic and mucic acids. Carbohydrates responding to these tests have been characterized by Tollen as Galactans.

We also found pentosans about 2·9 per cent, raffinose 2·1 per cent and dextrine 2·75 per cent as principal constituents of the carbohydrates. The high percentage of cellulose originally present got converted into more useful forms such as oxy and hydroxy cellulose during these treatments for the structural conversion of diketopiperazine linkage of soya bean amino acids.

These converted carbohydrates when tried on rats for digestive tests gave very satisfactory results.

Minerals (5 per cent).--The ash is very rich in phosphoric acid and potassium. Although the presence of iron, magnesium, calcium and sodium in fairly good quantities was detected, we preferred a further treatment with calcium lactate to increase the calcium content. By increasing the calcium content, the calcium phosphorus ratio could be made to approach 2 : 1.

Amongst other minerals, it contains, calcium 0·25 per cent, total iron 7·1 mgms. per cent, and ionisable iron 6·35 mgms. per cent. The ash was alkaline in reaction.

In dealing with soya bean as food, we have hardly touched upon its excellent industrial prospect, but experiments done in different lines, emboldens us to remark that every component of this wonder bean can be recommended as a source for big industries.

While, however, considering the deficiencies in the diet announced by the Government report at the beginning of this contribution, we can state that soya bean made more digestible after proper treatment is most suited as a balancing adjunct to the poor Indian diet. It shall at least supply people with the required quantity of biologically useful protein and unsaturated fats at a small cost.

A consumption of two ounces of soya bean powder to start with will almost balance the defective diets of an average Indian who is averse to meat diet and which he cannot afford for economic reasons and cannot use a sufficient quantity of pure milk.*

I tender my hearty thanks to Mr Amiya Kumar Banerji, B.Sc., Chemist to the Indian Health Institute and Laboratory Ltd., for helping in carrying out some of the most important experiments, without which this contribution would have remained incomplete.

BOOK REVIEWS

A Survey of General and Applied Rheology.—By G. W. Scott Blair. Sir Isaac Pitman & Sons Ltd., London. Pp. XVI + 196.

Dr Scott Blair has contributed considerably to the development of the new Science of Rheology. So a book on the subject from his pen is very welcome. The author intends the book mainly for the practical rheologist particularly for young physicists and chemists who have become rheologists by profession. The introductory chapter that comprises the history of the development of the science of rheology is an interesting and masterly survey of rheological knowledge beginning with the earliest records available on the subject. The rest of the book is divided into two parts. The first part contains analysis of the rheological phenomena and a critical review of the different methods of measurements of the various elements into which the complex rheological properties may be resolved. The second part deals with the interpretations of these measurements. The author here discusses the advantages and disadvantages of the different mechanistic models as well as the mathematical expressions for the representation of the phenomena and finds "that it is not widely realized how great a part the subjective testing of materials still plays in industry". He arrives at the conclusion that infinitely long time will elapse before mechanical measurement of all the rheological concepts of importance in industry will be made possible. Hence the author attempts in the last four chapter to bring psychophysical conceptions as far as possible into scientific alignment. The book is written throughout in a literary style rarely met with in scientific literature. The usefulness of the book has been increased considerably by inclusion of extensive classified references to literature on this subject.

K. B.

Soil Fertility as the Basis of Public Health.—(News Letter on Compost). Published by the County Palatine of Chester Local Medical and Panel Committee.

The three issues of the News Letter which appear in February, June and October of each year under the general title of "Soil Fertility as the Basis of Public Health" are published by the County Palatine of Cheshire Local Medical and Panel Committee as the result of their careful observation of the health of the people under their charge. Each number consists of some 50 pages of closely printed matter comprising correspondence, reprints of articles from agricultural or horticultural literature, and reports of public discussions notably those which have taken place in the House of Lords.

A study of these most interesting and important publications brings to mind a story illustrative of the British method of handling revolutions. The young communist excited after listening to Hyde Park oratory exclaims—"What we want is a couple of good machine guns." "What you want, my lad," says the kindly London policemen, "is a cupla asperins—move on." When we read such statements as "that the intrusion of quality into crop production automatically eliminates the statistician" and further that "the NPK mentality will have to be utterly discredited and destroyed," there arises a vision of agricultural research laboratories and their staffs disappearing in a rattle of machine guns. On the other hand it may be doubted whether the application of a mild sedative in the shape of rather old fashioned conservative criticism will stem the tide of new ideas revealed by these publications to be flooding in by various channels over the fields both of agriculture and of economics.

The foundational thesis of the Compost News Letter is to emphasize the need for a universal obedience of the "law of return" *i.e.* to give back to the soil all that has been withdrawn during the growth of the crop. In this return is included not only N.P.K. but unnumbered other elements living and non-living or it may be at least catalytic. Strangely it would appear that even international politics have entered into the question. After the third of Germany's five wars, *i.e.*, the Franco-German war of 1870, attention was chiefly given to the views of the German scientists Liebig, Schwann and Virchow. The French school was overlooked. It was Prof. Bechamp who urged the consideration of the lowest units of "life" which he declared were to be found not in the well recognised cell seen in the visible structure of living things but in what he termed "microzymases" or "little bodies" which he declared could actually be seen under the microscope, particularly in the blood stream. The essential point of the controversy between the "organic" and "mineral" schools is in the words of Lord Geddes in the House of Lords debate: "Is the supply of these little living bodies essential to the continued vitality of human beings or is it not?"

The use of properly prepared compost manure provides an unbroken *living* chain from soil to crop and from crop, by way of animal, back to soil again.

The importance of this chain is borne out by the varied and extraordinary evidence from all over

the world published in these News Letters. Of this evidence perhaphs the most important is given in the form of a Supplement to News Letter No. 9, June 1944, which is devoted to an account of "the People of the Hunza Valley."

Hunza lies to the north of Kashmir in the heart of the Karakoram range of mountains. This people numbering some 10,000 is a remnant of an old wave of migration which has survived 600 years. They are a courageous, hardy and happy folk. Although the people are 99% illiterate they have achieved difficult engineering works without mathematics, agriculture without chemistry, sufficiency without trade, health without medicine, and morality without moralizing. Their religion is a modification of Islam. High principle and healthy active life enables them to maintain racial purity while avoiding close inbreeding or artificial birth-control. Their national game is polo. There are no police and no murders. Their system of agriculture has been commented upon by Sir Robert McGarrison. It involves utilization of all available water by carefully devised terracing and in the present connection *all waste material is returned to the soil.*

This is an outstanding case of a whole people happily supporting itself through a fundamentally correct maintenance of soil fertility.

Among the varied and interesting evidence brought forward in the numerous contributions to the three numbers of the News Letter under review the following remain in the memory—*viz.*, the manginess of the lions in Cecil Rhodes' private Zoo at Cape Town, when they were fed on frozen meat and their prompt recovery on return to freshly killed fare ;—the way in which of two stored bins of wheat-grain, the rats attacked only the sample grown on soil manured with organics ; and such horticultural evidence as is afforded by the checking and final overcoming of virus disease in raspberries and strawberries by liberal application of compost. We learn that both the Government and the Municipalities of South Africa are becoming "compost-minded." It may well be regretted that it has taken so long to realize the true basis of South Africa's wealth.

The frequently raised question of cost is being met by the invention of the "muckshifting crane", devised by Mr F. Sykes of Chantry Chute, Wilitshire and now manufactured by the well-known agricultural engineers, Messrs. Ransom and Rapier of Ipswich. Thus compost-making is being "mechanized". Mr Sykes calculates that he can now produce compost at 1*s.* 8*d.* per ton.

In the realm of laboratory research attention is drawn to the problems connected with the activities of fungi in the compost heap and the possibility of utilizing woody matter through their activity and also the possible importance of penicillin effect in controlling the specific reactions in the composting process.

Altogether for the modest subscription of 5 shillings per annum, payable to Dr Picton, Hon. Secretary, Saddler's Close, Holmes Chapel, Cheshire a remarkable supply of provocative and stimulating reading is provided for the increasing number of those concerned in the various activities of the Grow More Food Campaign.

G. J. F.

The Peckham Experiment.—A study in the living structure of society by Innes. H. Pearse, M.D. and Lucy. H. Crocker, B.Sc. Published by George Allen and Unwin Ltd., London, 1943. Price 12*s.* 6*d.* net.

The work described in the book, is stated to be the outcome of the long continued interest of Dr Pearse in Infant Welfare arising out of her experience in this field in the East End of London. The joint author specialised in natural philosophy, taught biology in secondary schools and later on collaborated with Dr Pearse in the experiment described.

In social welfare work in general, selection is made for operation, of groups defined by age or sex, or economic condition or some similar characteristic. Such a separation is artificial and tends to ignore the real social forces that bind the units forming society. The fundamental social unit is the family, which is set up when a man and a woman agree to live together and have children, as part of society. In the Peckham experiment, an attempt was made to organise welfare work covering the entire family unit, and extending to the principal problems of health welfare as affecting all its members at different periods of their lives. A Health centre was established in 1926, in the Peckham area, providing facilities for the normal recreational activities that parents, and children—babies, small boys and girls, as well as adolescents—normally may be expected to take part in or seek facilities for, after work or school. At the same time there was an efficient health service, with medical advisers and biologists, willing to help at every stage in the growth of the family—mating, conception, childbirth, weaning as well as early education of the very young. The building is so designed that all general activities are observable without intrusion. This speciality in construction was necessary, not only for the observing biologist to do her work without breaking into any group, but also for the members to have the feeling of being part of an integrated social group. A member of a family could see other members of his or her unit at play or engaged in other activity,

without breaking up his or her own group activity. The design of the building was to promote sociability, through general visibility. The environment provided was to help the members of the family to develop through familiar nurture at each step to the non-familiar by gradual process of familiarisation in a normal social setting. The members of the family were not to develop by themselves, but to move together, through mutual interaction of their individual changes, and gains, and with the new social environment set up in the centre by their own activity.

The authors, through their observations at the centre have accumulated valuable data regarding deficiency in health and vital functions as well as defects in social functioning. A series of excellent photographs illustrate the different activities and aspects of work at the centre.

The details of the experiment can best be studied at first hand and should be studied by all social welfare workers. To the scientific student accustomed to concise statement of observations, some of the chapters will appear to contain unnecessary repetitions. The biological analogy of social functions is also occasionally pressed too far. The family life of the working class in England is rightly diagnosed to be suffering from social poverty. It is also correct that the family as such should be encouraged to take initiative in removing its defects. The centre aimed at securing this result. It is stated that a centre like that organised at Peckham can be self-supporting if each family contributes on an average two shillings a week. The initial capital outlay will however have to be furnished by a committee or a Trust or the State. From the statements regarding family life of the members available in the report, it can be gathered that the membership is confined to the wage earners, whose families have leisure. Their income is said to range from three pounds and a half to five pounds a week. Ninety per cent of the families are of wage earners either permanently employed or in regular and good employment. As the writers state "it does not represent any socially submerged, or financially impoverished populace". The Peckham centre has therefore furnished opportunities of health overhauls as well of making social contacts to these families, who had leisure and comfort but did not have opportunities of using their leisure to advantage. Although the writers have laid very great stress on function and the importance of appropriate functional adequacy in different periods of life, the experiment says nothing about the outlook on life of the members. Is it enough to give people opportunities of making their bodies healthy and getting to know each other like healthy animals? In the social group selected by the writers, wages it is said were not lacking, nor capacity, nor good will (as the authors put it). Was it merely lack of family and social opportunity that prevented integration as suggested? Was it not due to the lack of that amount of financial as well as organisational strength, which could have enabled the members to get together the necessary fifty thousand pounds to organise the centre? Had they this surplus saving for spending for their improvement? Was it not also due to failure on the part of the diversely employed two thousand families, to realise that they should have and could have a common social life? The family as a social unit has existed since the beginning of human culture. Among the modern primitive tribes, like our Mundas and Santals (or it was so also with the early Celts and ancient Germans of Europe) the solidarity of the family is extended to the village which is often an extension of the founders' families, and later comes to represent the extension of the family functions to the community occupying the same territory. The sharp division of labour, and dense aggregation of population brought about by modern industrial conditions has disrupted the earlier pattern. To make the units which are no longer kin-groups, function again, in the modern changed environment, as semiautonomous parts of a large organism, requires that the component units should be conscious of a common social purpose, and should have the necessary economic opportunities. We agree with the writers that "personal, family and social opportunity for knowledge and for action . . . should be the birth right of all". It is regrettable that the War led to the closing of the centre and the termination of this valuable experiment.

K. P. C.

Shakespeare's History Plays. —By E. M. W. Tillyard Litt.D. Chatto & Windus. viii + 336 pp. 18*s*. net.

The Olive and the Sword.—By G. Wilson Knight. Oxford University Press. 102 pp. 6*s*. net.

As the years roll on, the spate of books on Shakespeare shows no sign of diminishing. That, indeed, is not something to wonder at. What is wonderful is that so much of it should be of such excellence. And when Dr Tillyard or Mr Wilson Knight are the authors, everything is possible. They are old workers in a field from which they have always garnered a rich harvest—the meticulous scholarship of the one is as detectable as the enthusiasm of the other. The two books under review have something in common, and here and there touch common ground. But both try to recover the Elizabethan tradition,—Dr Tillyard by citing from contemporary literature covering a wide field, portions

of which, at least, were unexplored. Mr Wilson by reading between the lines of the text and deciphering the evidence as reflected in Shakespeare's use of imageries, analogies and words. Where, however, Mr Wilson is frankly topical Dr Tillyard aims at more permanent and precise valuations. With Mr Wilson, he underlines the essential moral background against which the Elizabethans saw historical events ; and both are at pains to point out that "Shakespeare's thinking functions continually in term of moral order." But whereas Mr Wilson abstracts and generalises, Dr Tillyard delves into the Elizabethan heritage of a cosmic background and puts forward arguments already familiar to readers of his *Elizabethan World Picture* as forming the basis of the history plays. Incidentally both refer to the Ulysses speech almost from the same standpoint, but Dr Tillyard's constant cross-references to contemporary ideas give a special significance where Mr Wilson is breezily discursive.

It is in his studies of historians like Hall and Holinshed as illustrating his thesis regarding the existance of a cosmic order which an able King preserves and an inefficient King disturbs with violent consequences, that Dr Tillyard has done the most valuable work. It places Shakespeare's conception of history in a new light and connects his plays not only with the chronicle plays but with the morality plays as well. At the same time it gives to the two tetralogies an unity that we had only vaguely apprehended. The patriotic motive is, of course, sufficiently underlined by both—by Mr Wilson with a topicality that Englishmen will relish. Dr Tillyard's precise scholarship is evident in every page and must overwhelm the lay reader into admiring acquiescence.

On the interpretation side, it might be possible not easy to disagree with Dr Tillyard. The weight of authorities cited is all in his favour and in point of judgment, his exact knowledge of the age reinforces arguments which would otherwise (as in Mr Wilson's book) have remained stimulating generalisations at best. As an example, we might refer to the rejection of Falstaff by Henry V. The vitality of the creation has so deflected judgement and emphasised our sympathies that we do not realise the impossibility of Falstaff as the boon companion of a young King who despite all his escapades was never a fool. It is in Shakespeare's defence of Henry V from the charge of heartlessness, that the significance of the cosmic pattern is understood and the connection between the sections on "The Background" and "Shakespeare" is appreciated. The scheme of alternation between a good King and a bad King has a Hegelian symmetry which re-acts on our interpretation of each play.

In one respect, Mr Knight goes behind Dr Tillyard. He was the first to work out the intimate connection between the cosmic world and the individual man—the peace or disturbance in the one being reflected either magnified or caricatured in the other, a point which has been more convincingly worked out in his *The Wheel of Fire*. But the present work is much less pretentious and far more topical. The discovery of Hitlerism in the Tamburlaine type is more interesting than illuminating and shows how Shakespeare bids fair to pass out of the artistic stage into the scriptural where each text becomes the theme of a sermon. Yet there is much in the volume that is original and revealing. In the light of Dr Tillyard's exposition of the Tudor Myth, the rehabilitation of Henry VIII as a definitely Shakespearean play deserves the closest attention. But we confess once again to our inability to appreciate the attempt to allegorise and moralise Shakespeare's plays. Further, the imagery motif is being too much overworked and the labour spent is not commensurate with the results achieved.

D.G.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ON THE ASSAY OF ALKALOIDS IN KURCHI BISMUTH IODIDE

KURCHI bismuth iodide is usually assayed according to the British Pharmacopoeial[1] method of assay for emetine and bismuth iodide as modified by Evers and Smith[2] and by Karkun and Guha.[3] For the assay of alkaloids, the salt is decomposed in acetone solution with strong hydrochloric acid, and citric acid is added to form a compound with bismuth soluble in ammonia. The alkaloids are set free by addition of ammonia and are extracted out with chloroform and dried and finally weighed. Karkun and Guha mentioned that in some samples the liquid after the addition of ammonia remains turbid, probably due to resinous impurities, and the presence of the precipitate promotes emulsification. This formation of emulsion is rather common with average samples, and when emulsification occurs, the extraction of alkaloids is hindered, often leading to low results in the assay.

This precipitate is liable to contain bismuth hydroxide ; citric acid is added to prevent its formation, but the quantity suggested, namely, 0·5 gm. in 10 c.c. of water for 0·3 gm. of the substance, has been found to be insufficient in most cases. If the quantity of citric acid is increased to 1·0 gm. the formation of bismuth hydroxide can be safely avoided.

Even after adopting the above change, turbidity is often observed in the ammoniacal liquid. On filtration a clear solution is obtained, from which the alkaloids can be extracted with chloroform without any difficulty.

In the ammoniacal liquid, the free alkaloids exist in the form of a fine suspension, part of which may be retained on the filter along with the impurities. This alkaloid can be recovered by extracting the filter with several portions of chloroform, until all the alkaloid has been removed, and adding this chloroform to the main chloroform extract.

By adopting the above modifications in procedure, any difficulty due to emulsification can be easily avoided, and a uniformity in the results of assay is obtained.

S. MUKHERJEE
B. C. DUTTA

Bengal Immunity Research Laboratory,
Baranagar, Calcutta,
21-2-1945.

[1] British Pharmacopoeia, 1932.
[2] Evers and Smith, *J. Pharm. Pharmacol.*, *11*, 758, 1938.
[3] Karkun and Guha, *J. Proc. Inst. Chem.*, *15*, 59, 1943.

PHASIC DEVELOPMENT OF PADDY

SERIES of investigations have been continued in this Institute to study the nature of the phasic development and the problem of vernalization of certain important varieties of paddy grown in Bengal. Recently Parija and Pillay[1, 2] have investigated in this connection the effect of pre-sowing temperature treatment and anaerobiosis on drought resistance, flood resistance and yield. Sarkar[3, 4] has tried to vernalize certain varieties of paddy by light treatments and has shown that short days accelerate ear-emergence, increase growth rate and grain yield. Hedayatullah and Sen[5] have noted the effect of pre-sowing high temp. treatment on few *aus* varieties. The preliminary results in this series on certain *aus* varieties have already been reported[6], and certain observations on few *amon* varieties are given below :—

Eight varieties of *amon* paddy *viz.*, Bhasamanik, Latisail, Patnai, Jhingasail, Chinsura II, Badkalamkati, Nagra and Tilakkacheri were given pre-sowing treatment of (*a*) high temperature (34°—35°C) for 3, 7 and 15 days by means of the vernalization apparatus ; (*b*) cold temperature (6°—8°C) for 15 and 30 days. Further the effects of different post-sowing photoperiods of short-day cycles (8 hours light period alternating with 16 hours dark period) ; of long days cycles (17 hours light period alternating with 7 hours dark period) and also different combinations of the two cycles (long days⟹short days), at different ages of the seedlings on growth, tiller output, initiation of flowering and yield were noted.

The results indicated that pre-sowing temperature treatments either warm or cold are of varietal nature. Chinsura II, Badkalamkati and Tilakkacheri responded to high temperature treatment and showed an earliness of 18, 13 and 5 days respectively, while the other varieties showed no appreciable earliness. No effect was also seen in the matter of earliness of flowering as a result of pre-sowing cold treatment. The effect of pre-sowing temperature treatment on earliness has been given in Table I.

The pre-sowing treated seedlings when further allowed to grow under controlled cycles of light and dark periods, showed an increased vegetative growth and tiller output with a significant earliness in ear-emergence under conditions of short day lengths. The effect of different photoperiodic treatments on tiller output has been given in Table II.

It was seen from the table II that short day lengths induced an increase in tiller output than the

TABLE I

EFFECT OF PRE-SOWING TEMP. TREATMENT ON INCIDENCE OF EAR-EMERGENCE AS COMPARED TO CONTROL

(Mean of 10 plants)

+ indicates earliness; – indicates delaying effect.

Varieties	Control in days	Pre-sowing temp. treatment				Earliness or late due to			
		Warm (34°-35°C)		Cold (6°-8°C)					
		A—3 days	B—7 days	C—15 days	D—30 days	A	B	C	D
Bhasamanik ...	125	125	125	129	123	Nil	Nil	–4	+2
Latisail	120	120	121	122	120	Nil	–1	–2	Nil
Patnai	126	—	126	123	125	—	Nil	–3	+1
Jhingasail ...	122	—	122	121	125	—	Nil	+1	–3
Chinsura II ...	125	—	107	127	126	—	+18	–2	–1
Badkalamkati ...	119	—	106	—	—	—	+13	—	—
Nagra	127	—	127	127	129	—	Nil	Nil	–2
Tilakkacheri ...	128	—	123	123	129	—	+5	+2	–1

TABLE II

POST-SOWING PHOTOPERIODIC TREATMENTS ON TILLER OUTPUT

(Mean of 10 plants)

Treatments	Age in days	Bhasamanik	Latisail	Patnai	Jhingasail
Control	68	2·5	Nil	Nil	Nil
	77	2·5	3·0	4·0	1·0
	89	11·0	11·5	4·0	4·5
	108	12·0	11·5	4·5	5·0
Short days	68	5·0	4·0	Nil	Nil
	77	5·0	4·0	1·0	1·0
	89	16·0	13·0	5·0	5·5
	108	16·0	13·0	6·5	7·5
Long days	68	3·0	1·0	Nil	1·0
	77	8·0	3·0	2·0	1·0
	89	14·0	11·0	4·0	2·0
	108	14·0	11·0	4·0	2·0
Short days (15 days) } Long days (15 days) } ...	68	3·0	Nil	Nil	Nil
	77	3·0	5·0	2·0	5·0
	89	16·0	13 0	10·0	13·0
	108	16·0	16·0	11·0	12·0
Long days (15 days) } Short days (15 days) } ...	68	2·0	2·0	Nil	1·0
	77	6·0	6·0	2·0	2·0
	89	11·0	15·0	5·0	9·0
	108	11·0	15·0	6·0	10·0

long day conditions in all the varieties as compared to the control. It was interesting to note that after short days if a period of long days was allowed to follow then a further increase in tiller number was noted. But when the sequence of the day lengths was reversed, to that of long days followed by short days, then a decrease (except in Latisail) in the number of tillers resulted.

The induced effects of these different day lengths on the time of ear-emergence, showed a significant earliness in all the varieties under short day conditions of while long day conditions delayed the ear-emergence. If after short day treatments of 15 days an equal period of successive long days was given then the induced earliness of the short days remained and behaved independently of the following day length. Similar behaviour was noted in case of reversed photoperiods of long days first and then followed by short days *i.e.*, the induced delayed effect brought about by long days persisted even if a period of short days followed. If the normal cycle of light⇌darkness be disturbed by introducing a period of extended darkness of 72 hours then delaying effects both in tiller output and ear-emergence

resulted. The effects of photoperiodic treatments on the incidence of ear-emergence have been summarised in Tables III and IV.

TABLE III

EFFECT OF DIFFERENT POST-SOWING PHOTOPERIODIC CYCLES ON THE INCIDENCE OF EAR-EMERGENCE

+ indicates earliness; − indicates delaying effect.

Varieties	Age at the time of treatment	Control	Different photoperiodic cycles		Difference from control due to	
			A—Short days for 15 days	B—Long days for 15 days	A	B
Bhasamanik	68 days	126·0	112·8	127·8	+13·2	−1·8
Latisail	68 ,,	120·8	105·3	126·5	+15·5	−5·7
Patnai	76 ,,	125·0	111·0	126·5	+14·0	−1·5
Jhingasail	76 ,,	124·5	112·5	127·7	+12·0	−3·2
Chinsura II	89 ,,	121·3	112·7	118·7	+8·6	−2·6
Badkalamkati	89 ,,	119·0	106·0	115·2	+13·0	−3·8
Nagra	89 ,,	127·5	121·5	133·0	+6·0	−5·5
Tilakkacheri	89 ,,	126·5	120·0	134·0	+6·5	−7·5

TABLE IV

EFFECT OF POST-SOWING PHOTOPERIODIC CYCLES ON THE INCIDENCE OF EAR-EMERGENCE

+ indicates earliness; − indicates delaying effect.

Varieties	Age at the time of treatment	Control	Different photoperiodic cycles			Difference from control in		
			C—Short days (15 days) Long days (15 days)	D—Long days (15 days) Short days (15 days)	E-Normal days (3 days) alternating 72 hrs dark (15 days)	C	D	E
Bhasamanik	68 days	126·0	114·0	124·8	131·0	+12·0	+1·2	−5·0
Latisail	68 ,,	120·8	112·5	125·2	128·0	+8·3	−4·4	−7·2
Patnai	76 ,,	125·0	118·2	126·7	136·0	+6·8	−1·7	−11·0
Jhingasail	76 ,,	124·5	120·0	131·0	134·0	+4·5	−6·5	−9·5

The above results clearly indicated that (*a*) to pass the photostage of paddy short days are essential, (*b*) long days at photostage delayed the earing, (*c*) when once the photostage was passed under short day conditions even successive long days showed no delayed effect, (*d*) delaying effect induced by long days at photostage was not recovered by successive short days, (*e*) periods longer than 24 hours cycle showed delaying effect. Further work on the definite range and duration of photostage and the variations in the light and dark periods, essential for inducing earliness, are in progress and the detailed results would be published elsewhere.

We are thankful to the management of the Bengal Immunity Co. Ltd. Calcutta, for sanctioning a suitable grant to carry out the above scheme of investigations and to Prof. D. M. Bose, the Director of the Bose Institute for his encouragement and interest in the work.

B. K. KAR
A. K. ADHIKARI

Bose Research Institute,
Calcutta, 7-3-1945.

[1] Parija, P., *Cur. Sci.*, *3*, 89, 1943.
[2] Parija, P. and Pillay, K. P., *Cur. Sci.*, *13*, 183, 1944.
[3] Sarkar, S. M., *Nature*, *153*, 378, 1944.
[4] Sarkar, S. M. and Parija, B., *Proc. Ind. Sc. Con.*, 1945.
[5] Hedayatullah, S. and Sen, N. K., SCIENCE AND CULTURE, *3*, 89, 1943.
[6] Kar, B. K., *Proc. Ind. Sc. Cong.*, 1945.

BAND INTENSITY DISTRIBUTION IN RELATION TO COMPLEXITY OF SUBSTANCES

Tawde and Trivedi[1] have reported some results on the problem of vibration temperature in relation to rotation temperature in band spectra. They adopt a method in which gross intensity distribution is measured along band systems of two different molecules, *viz.*, CN and AlO excited and observed simultaneously in the same excitation source. This led the authors to undertake a similar problem, but bearing on other aspects. We undertook investigations on the same band system arising out of substances of chemically different compositions in the same excitation source, a problem somewhat analogous to that of Lochte-Holtgreven[2] on C_2 and CH bands. The nature of the investigation is entirely different from the work of Johnson and Tawde[3] who examined the C_2 (Swan) system under varied excitation conditions.

Carbon arc in air was selected as the source of excitation because of the existence of temperature equilibrium in it, as established by various experiment by independent methods. The arc was fed in its lower carbon anode with (*a*) powdered oxide of aluminium (Al_2O_3) and (*b*) metallic aluminium in the form of filings to give the band system of AlO ($B^2\Sigma \rightarrow X^2\Sigma$). The observations were extended to BeO ($^1\Sigma \rightarrow {}^1\Sigma$) bands obtained respectively from substances, beryllium oxide (BeO) and metallic beryllium powder. The arc conditions were kept strictly constant in all the four cases.

Intensity measurements were made by the well-known methods of photographic photometry used by Johnson and Tawde, Tawde and Desai[4] and others. On the assumption of the Boltzmann distribution of vibrational energy, effective temperatures were calculated for each of the four cases mentioned above. The values are given below:

Band system	Effective temperature	
	Oxide substance, T_o	Metallic substance, T_m
AlO ($B^2\Sigma \rightarrow x\,^2\Sigma$) ..	2570° K	3525° K
BeO ($^1\Sigma \rightarrow {}^1\Sigma$) ..	3330° K	4590° K

The above results show a marked difference of about 1000° between the temperatures derived from the oxide and metallic substances in the same arc. The absolute value T_m for AlO system 3525°K agrees quite well with Tawde and Trivedi's result 3450°K. The ratio T_m/T_o for both the systems comes out to be nearly the same *i.e.*, 1·38 for BeO and 1·37 for AlO.

The different temperatures derived for the same band system may probably be attributed to the particular chemical composition of the substance giving rise to the system. It should happen that the substance, before excitation of the particular band system concerned, passes through various thermal processes induced by the energy of the arc. These energies must evidently differ for metallic substance and its given oxide. They should, under constant arc conditions, be proportional to the temperatures computed from the band spectra. Under certain limitations and with available knowledge of the constants of the substances used, we have found that the agreement is good.

If radial temperature slope is, as shown by Tawde and Trivedi assumed to exist within the arc, the different substances according to their chemical composition and binding are removed to that region of the arc where they get appropriate energy for the formation of the molecule and stable excitation of the system. The computed temperature then corresponds to that region. Actually, it was noticed in every case that different zones of the arc had to be focussed to record the systems, which is an evidence for the above view. For instance, in the case of AlO system arising from oxide substance, it was the outermost fringe (flame portion of the arc) that was identified as rich in these bands. For this, we should expect to get the lowest temperature as has been found here.

The observations, therefore, prove that in spite of band system remaining the same and excitation source remaining the same, the intensity distribution is a function of the complexity of the substance which breaks up or oxidises to form the given radical.

The details of the results and other aspects which remain to be discussed will be published elsewhere in a full paper.

N. R. Tawde,
A. G. Husain.

Physics Laboratories,
Royal Institute of Science,
Bombay, 22-3-1945.

[1] *Nature*, *140*, 463, 1937; *Proc. Phys. Soc.*, *51*, 733, 1939.
[2] *Zeit. f. Phys.*, *64*, 443, 1930; *67*, 590, 1931.
[3] *Proc. Roy. Soc. A*, *137*, 575, 1932.
[4] *Proc. Ind. Acad. Sci.*, *6*, 266, 1937.

REPRODUCTION OF A GIVEN TIDE BY THE PNEUMATIC TIDE-GENERATOR

In a previous communication[1] the general principle of the pneumatic tide-generator was described. The widths of the feed- and exhaust cock openings at any instant were given by $y = m\frac{dh}{dt}$, where $\frac{dh}{dt}$ is the rate of tidal rise or fall of water level at that

instant, and m the constant of proportionality. The value of m is however different for feed and for exhaust, and to avoid confusion we may put $z=n\frac{dh}{dt}$ for the instantaneous width of the 'exhaust' opening. The derivation of the formulas assume that the feed or exhaust of air takes place under a constant pressure across the tidal cock.

The tidal generator was employed to reproduce a particular tide in a small pilot model of the Kultigong river. Both the feed and the exhaust slots were figured according to the above formula. The experiment was performed with feed pressure of air at 27 cm. of mercury (=5 lb./sq. in.) and the rising part of the tidal curve (fig. 2) was satisfactorily reproduced without retouching the cock figure or adjustment of the regulating cocks (trimmers). The maximum change of pressure in the pneumatic chamber caused by the displacement of water was nearly 30 cm. of water head or only about 8 per cent of the feed pressure.

Owing to certain considerations the exhaust nozzle of the pneumatic tidal cock was not connected to any stabilised vacuum of the similar order although the above formula was employed on the assumption

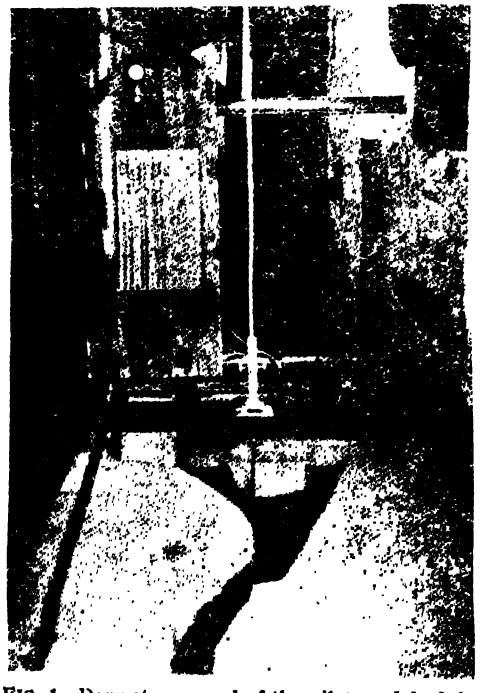


FIG. 1. Downstream end of the pilot model of the Kultigong river (tidal), with control board, etc.

of stabilised exhaust. The exhaust was, in the experiment, kept open to atmosphere and the ebb took place under the pressure of its own head, *i.e.*, the difference of level of water in the pneumatic chamber and open tidal section. Evidently enough, as the ebb proceeded the head diminished so that the exhaust of air was rendered slower than desired. This necessitated the adjustment (opening out) of a trimmer cock, indicated by the setting (*iv*): the general settings of the experiment being as follows:

(*i*) Normal filling of water, when both sections have the same level, at −0·16 ft.
(*ii*) Feed pressure of air during flow tide, kept steady at 27 cm. of mercury (or 5 lb./sq. in.).
(*iii*) Tidal cycle 2 min. 55 sec.
(*iv*) Auxiliary trimmer cock during exhaust at ebb stages: At 14 hr. opened at dial mark 4, and at 16 hr. opened further at mark 2.

The reproduction of the tide is shown in fig. 2.

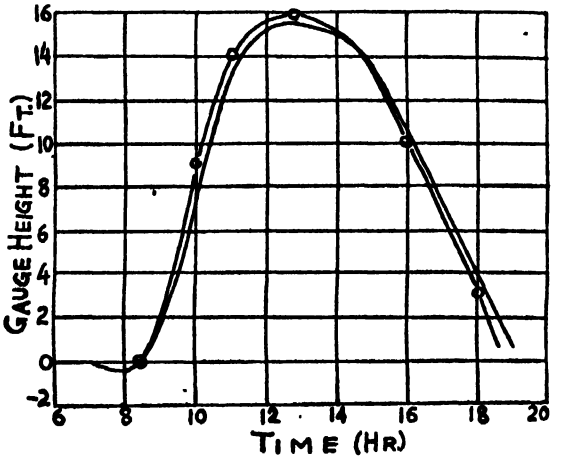


FIG. 2. Reproduction of a tide by the pneumatic control. The curve with circles is experimental.

As noted before, the exhaust should, for certain reasons, be better released in atmosphere than connected to the suction line of the compressor. Under such condition the width of the exhaust slot should be modified to $z=\frac{1}{p}n\frac{dh}{dt}$ where p is the water head at any instant for which the rate of ebb is noted.

Details will be published elsewhere.

My thanks are due to Prof. M. N. Saha, D.Sc., F.R.S., and Dr N. K. Bose, Ph.D. for taking keen interest during the progress of the work.

KAMALESH RAY.

Palit Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta, 3-4-1945.

[1] K. Ray, SCIENCE AND CULTURE, *10*, 212, 1944.

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THE GAME WITH HUMAN LIVES

"Woe betide the land, to ravenous wolves a prey,
Where millionaires flourish, and millions decay".

THE tragedy that Bengal witnessed in 1943 was unparallelled in history both in intensity and character. The famine has not only taken a huge toll of human life but has left appalling wreckage. The loss in life has been larger (one and a half millions according to the report, but three and a half millions according to non-official estimates) than that occasioned in these six years of war in the U. K. and U. S. A.

India is mainly an agricultural country ; is it not an irony of the first magnitude that this agricultural land where 70 per cent of 400 millions is engaged in food production should so frequently be a victim of famines? The climax of the tragedy is all the more heightened when it occurs in Bengal often called the 'granary of India'. What is most agonizing that this famine did not come as an entirely unexpected avalanche ; its incidence was forecast by the public long before the Governments of Bengal and India could be made to agree to its occurrence although the District Officers had been warning the Government against the impending catastrophe. With bold and resolute action, it could have been prevented ; at least its effect would not have been so disastrous.

A post-mortem examination has now been carried out on the Bengal famine of 1943. The Famine Enquiry Commission set up by the Central Government, with Sir John Woodhead (late of I.C.S.) as Chairman,* has now released a report in which the situation prevailing before and during the famine has been analyzed. It is note-worthy that most of the charges of maladministration brought against the Bengal Government by the public during the famine, and which were often stoutly refuted by the authorities, are very largely substantiated in this report. Broadly speaking, the findings of the Commission are :

I. That the incidence of the famine was not sudden, the signs of the catastrophe were apparent several months before its actual occurrence.

II. That although shortage of food supply and fall of Burma created conditions for its occurrence, its incidence was mainly due to (1) the sudden increase in the price of food materials, (2) the terribly low purchasing power of the people, (3) the confusion in the policy of the Government regarding control of prices and procurement of food grains through Government agents, (4) the panic in the adjoining areas after the fall of Burma, (5) the weak and vacillating policy of the Government to control hoarding and increase of prices, (6) the maldistribution of available supply, (7) unfortunate Government propaganda against the incidence of famine when thousands were dying daily, (8) Government's failure to make an early declaration of famine and consequently delay in the adoption of relief measures, (9) unrestricted free trade, (10) export of rice from Bengal to other areas, (11) heavy purchases by the Army, huge stocks accumulated by industrial and Government employers, (12) destruction and loss of coastal boats, (13) lukewarm and complacent attitude of the Government of India and His Majesty's Government, (14) hoarding and greed for money even at the expense of human lives, and above all due to lack of enlisting public support and loss of public confidence in the capacity of the Bengal Government

* The other members of the Commission were—(1) Sir Manilal B. Nanavati, M.A., B.L., (2) Dr M. Afzal Hussain, F.N.I., (3) Mr S. V. Ramamurty, I.C.S., (4) Dr W. R. Aykroyd, D.Sc. and (5) Mr R. A. Gopalswami, I.C.S. (Secretary).

to take effective measures even under the most acute conditions.

Report of Famine Commission

The last one completely shattered the morale of the population and created utterly chaotic conditions and feelings of extreme individualism. In similar circumstances, other provinces and States similarly situated with regard to food conditions, by taking timely and effective steps, acquitted themselves much better* and saved an All-India catastrophe. The report† says:

"A breakdown in distribution could be averted only by an intervention of Government, which would have the effect of restoring public confidence and of demonstrating to producers and traders the determination and the ability of Government to prevent a further rise in prices, and of assuring traders and consumers that the flow of supplies would be maintained."

"The rise of prices, which we hold to be the second basic cause of the famine, was something more than the natural result of the shortage of supply which had occurred. It was the result of the belief of the producers, traders, and consumers in Bengal at the end of 1942 and the beginning of 1943 that an ever-increasing rise in prices was inevitable and could not be prevented. This belief had been created, not only by the failure of the *aman* crop but by the entire course of events during 1942."

"In these circumstances, an attempt to control prices by the prescription of statutory maxima aggravated the situation by driving stocks under-ground. The subsequent decision not to enforce the Order, while alleviating the difficulties which the Order created, advertised the inability of Government to control the markets."

"The failure of price control had caused a loss of confidence in the ability of Government to control the markets, and it was important that Government should demonstrate without delay their determination to prevent a further rise in price, and to assure traders and consumers that the flow of supplies would be maintained."

"The events of 1942 had shown how necessary it was for the Bengal Government to secure control of supplies. In these circumstances, we think that the wise course would have been for Government to have recognized that it was inadvisable to wait for a decision whether the control of rice should be central, provincial or regional responsibility, and that the proper course was to establish as quickly as their own procurement machinery."

Profiteers make Thousand Rupees for one Life!

"It has been reckoned that the amount of unusual profits made on the buying and selling of rice during 1943, was 150 crores.* We cannot vouch for the accuracy of this figure, but beyond question huge profits were made. Very naturally, in the circumstances, there was great indignation against "profiteers, speculators, and hoarders", to whose greed the famine was ascribed; while equally naturally the Government were blamed for their failure to deal drastically with such enemies of society. Popular views about large profiteers who speculated and hoarded amid growing distress, and the inability of Government to control them, were indeed not without foundation. There were such profiteers, but they were not the only culprits."

"We have shown that by the end of 1942 all the signals were set at danger and that great efforts were needed to avoid catastrophe. We do not, however, wish to imply that famine, in the form in which it finally appeared, had become inevitable. The lack of political unity was a handicap, but the possibility of effective leadership of the people, and effective action stimulated by such leadership, had by no means disappeared. It may be that when this stage was reached, distress and starvation, in some degree, could not have been entirely averted. But opportunities for mitigating the famine and its lethal results still remained open."

"We have been told that Government advised people that there was no shortage at a time when everybody knew that there was a shortage, and that this increased the prevailing lack of confidence."

"Conditions actually prevailing in Bengal at the time were far too serious for anyone to believe anything of the kind. We consider that this propaganda of sufficiency was quite ill-advised. We think that it would have been wiser to have told the people the truth, that is, that there was a shortage, and that although it was hoped to obtain supplies from other provinces it was essential, if famine was to be averted, that everybody who had stocks should dispose of them without waiting for higher prices. It was considered at the time that it was inadvisable to alarm the public by referring to the possibility of famine, and that was undesirable that the enemy in Burma should be acquainted with the serious position in regard to food supplies in Bengal. We are not impressed by these arguments. The emergency was such -famine started in Chittagong by the beginning of June—that it could not be hidden, and in the circumstances it was essential that the people should be truthfully informed about the real position."

"The remarkable feature of the Bengal famine was that the rise in the price of rice was one of the principal causes of the famine. This, as far as we are aware, makes it unique in the history of famine in India. The great majority of Indian famines have been caused by drought and widespread failure of crops over wide areas. Floods, hail, and cyclones have on rare occasions produced the same effect."

"One of the reasons why the arrangements made by the Government of Bengal to deal with transport and other problems arising during the famine were unsatisfactory

* In Bengal, the food shortage is estimated by the Commission at only 15 per cent. In Cochin and Travancore, the food shortage amounted to about 40 per cent., yet in these Indian States, not many people are known to have died of starvation because strict and effective measures were taken in time, and the Maharajah and Dewan shared privation with the common people. What a contrast to the conditions in Bengal (a British Indian Province) where the Government officials were denying the existence of famines, and having their luxurious dinners and lunches, when people were dying of starvation in the streets of Calcutta!

† Report on Bengal, Famine Enquiry Commission, 1945, pp. 80—107.

* The details of this gruesome calculation are as follows: Normally, about 4·5 million tons of rice and paddy in terms of rice pass through the markets and are bought by consumers in the course of the year. At least 5/6th of this quantity, or 3·75 million tons, must have been bought during 1943. Judging from the differences in the prices which prevailed during 1942, and those which prevailed during 1943, as well as the available statistics about prices which actually were paid during 1943, the average difference was not less than Rs. 15 per maund or Rs. 400 per ton in round figures. Hence the figure of Rs. 150 crores as the excess price charged for 3·75 million tons during 1943. Thus every death in the famine was balanced by roughly a thousand rupees of excess profit.

was that they failed to realize the magnitude of these problems and the scale of the organization required for their successful solution. Associated with this was a reluctance to appeal for outside help even when the organization and personnel available within the province were obviously inadequate. We feel that this attitude was particularly unfortunate in the circumstances."

"If the interests of the rural population had been kept more prominently in mind, the mistaken policies of "de-control" and "unrestricted free trade, the relaxation of the Foodgrains Control Order and other policies which encouraged profiteering and hoarding would not have been adopted."

"The failure of the *aman* crop at the end of 1942, in combination with the whole existing set of circumstances, made it inevitable that, in the absence of control, the price of rice would rise to a level at which the poor would be unable to obtain their needs. It was necessary for the Bengal Government to undertake measures for controlling supplies and ensuring their distribution at prices at which the poor could afford to buy their requirements. It was also necessary for the Government of India to establish a system of planned movement of supplies from surplus to deficit provinces and States. This rise in prices was the second basic cause of the famine. Famine, in the form in which it occurred, could have been prevented by resolute action at the right time to ensure the equitable distribution of available supplies."

"But after considering all the circumstances we cannot avoid the conclusion that it lay in the power of the Government of Bengal, by bold, resolute and well-conceived measures at the right time to have largely prevented the tragedy of the famine as it actually took place. While other Governments in India were admittedly faced with a much less serious situation than the Government of Bengal, their generally successful handling of the food problem, and the spirit in which those problems were approached, and the extent to which public co-operation was secured stand in contrast to the failure in Bengal"

"Enormous profits were made out of the calamity, and in the circumstances, profits for some meant death for others. A large part of the community lived in plenty while others starved, and there was much indifference in face of suffering. Corruption was widespread throughout the province and in many classes of society."

"It has been for us a sad task to inquire into the course and causes of the Bengal famine. We have been haunted by a deep sense of tragedy. A million and a half of the poor of Bengal fell victim to circumstances for which they themselves were not responsible. Society, together with its organs, failed to protect its weaker members. Indeed there was a moral and social breakdown, as well as an administrative breakdown."

These observations of the Committee confirm in detail and with fresh figures the analysis which had been made in the public press at the time of the famine and in the columns of this journal. The report makes it clear that it was a *man-made* famine and that it was ***preventible.***

No Foreign Aid Allowed

It is unfortunate that the Bengal Government right from the beginning insisted that the shortage in the supply of rice did not exist and, therefore, did not make strenuous attempts either to get rice or any alternative foodstuff from the surplus areas, or to import wheat from Australia into India which at one time Mr Seely, the Australian Minister of Agriculture, said was lying in the Brisben port to the extent of about 1½ million bushels to be shipped to India if only His Majesty's Government would release shipping for the purpose. It will be recalled that at that time Mr Amery pleaded lack of shipping. The hollowness of this pleading would be clear when it is considered that Britain always managed to have enough shipping to get supplies for herself so that during the war Britain has been fed at a high level of nutrition and not a single individual died of starvation. Even when famine was raging in Bengal, ships could be found for feeding the occupied countries in Europe particularly German occupied Greece, but the country which was spilling her blood to liberate Europe was allowed to starve. What an equitable treatment indeed! It is obvious that if no shortage in supply is admitted the cause for the disaster must be sought elsewhere. The Government all the time insisted that hoarding by individuals was the main cause of this apparent scarcity and, therefore, they did not feel any particular responsibility regarding the urgency of importation of food from abroad. But who else except the Government could stop this hoarding*? It is clear that if ships carrying food from abroad had come in early June or July of 1943, hundreds of thousands of lives could have been saved.

This journal had considered the food situation both before and during the famine, had analyzed the causes which were leading to the famine and suggested concrete remedies insisting on the question of importation of food.† The commission has not discussed the lack of subsidy to the food growers from the public exchequer which could have considerably stimulated food production and also helped the control of prices, which otherwise, it is well-known, cannot be effected merely by governmental decrees.

Food Measures in England

The report has made one very serious omission in that it has not described what drastic steps were taken and what organisations were set up in other independent countries and particularly in the homeland of our trustees.

Why indeed has Bengal suffered from a famine of this nature while the United Kingdom which produces considerably less food per head of the population has been comparatively very well fed? England had need

* In some of the worst affected areas of Dacca, even the black market did not exist, for there was no hoarded food to be placed in the black market.

† 'The Crisis in Food' by B. C. Guha ; Science and Culture, Vol. 8, 403.

for far more shipping space to import food than India relative to the population. What were the policies, scientific, technological, nutritional and administrative, which have not allowed the prices of staple food stuffs in England including cereals, bread, milk, cheese, butter and meat, to go beyond 25 per cent above the pre-war price level? Even now in England potatoes sell at barely 2½ annas a seer, whereas in hardly any city in India it has sold for less than 8 annas for a long time, and this in spite of the fact that the average income of an Indian is only a fraction of that of a Britisher. Even in such a wealthy country as the U. S. A., where the minimum wage is of the order of Rs. 450/- per month the price of potatoes is roughly 4 annas a seer. Why is it that black markets have flourished far less in the United Kingdom than here? These are all questions which, if they had been discussed in relation to the administrative measures taken in India, would have thrown a more penetrating light on the situation that prevails in this country and on the methods that the Government in this country must adopt to meet the conditions in India.

The methods adopted in the U. K. as soon as the war broke out, to control the food situation in England were briefly as follows:—

First of all, the Government established a Scientific Division of the Ministry of Food to advise it on all scientific and technical questions relating to food. This scientific division calculated the needs of the people of the United Kingdom in terms of different food-stuffs according to the internationally accepted nutritional standards. Then the production of food-stuffs in Britain during pre-war period was compared with the requirements for optimum nutrition. The deficit was sought to be met (1) by increased production in Britain and (2) by importation. It was decided that internal production should be largely forced up for more energy-giving food-stuffs, namely cereals and potatoes, as these were bulky food-stuffs and required rather large shipping space for importation. Regarding imports it was decided that the so-called protective food-stuffs like eggs and milk in the dehydrated condition, and orange juice, liver oil concentrate etc. should be imported, as this class of foodstuffs providing the proteins and vitamins, was required in relatively smaller quantities than the cereals and potatoes. In other words, both home production and importation were entirely under scientific advice and the importation of such foodstuffs as bananas which were relatively less important than orange juice from the standpoint of vitamins was severely restricted.

Secondly, to encourage home production very large subsidies of over two hundred crores of rupees were given to the producers of food of all kinds including meat and milk in order (*a*) to encourage production and (*b*) to prevent the undue rise of prices of these primary commodities. The Government had a policy of systematic importation of foodstuffs in order to keep up sufficient reserves in the country. This situation regarding both subsidy and importation may be contrasted with ours. The great expansion of agriculture in the U. K. during the war was possible partly because of the scientific planning and guidance but mainly of the large direct subsidy from the State to the food-growers. This was a major factor for the stabilisation of food-prices in the U. K. but this was never attempted in this country. The result was a far greater economic loss due to the famine, apart from the loss of life, than any possible loss due to subsidy.

Thirdly, the Government organised the feeding of the people on scientific lines not merely by rationing but by organising what are called 'the British Restaurants' where cheap balanced meals were provided to the people. These restaurants are run by the County Council Organisations under the supervision of the Ministry of Food. Free milk was distributed to about a million children and other children also received very cheap milk. Children as well as expectant and nursing mothers were given special doses of orange juice and shark liver oil concentrate and where women could not tolerate the shark liver oil concentrate special capsules containing vitamins A and D were provided. To ensure that the entire population could get as much of the vitamins of the B-group as possible, 80 per cent. extraction of flour from wheat was enforced by law. This increased considerably the quantities of thiamin, riboflavin and pyridoxin in the flour. This was enriched by incorporation of 0·16 per cent of calcium carbonate to supply calcium which is nutritionally very valuable. It is no wonder that according to Sir Jack Drummond, the chief Scientific Adviser to the Ministry of Food, the poorer population of Great Britain is better fed today than before the war. It is reported that the average stature of young boys and girls has also definitely increased compared with pre-war figures. The overall situation of England today is, therefore, that although the food is somewhat more monotonous than before the war, the food provided to the general population is adequate with regard to optimum nutritional standards.

Who is responsible for the Famine? Break down of Trusteeship Government

The advocates of trusteeship policy will fix the responsibility on the Bengal Government. The Members of the Bengal Ministry will probably hold that although they were given the charge of admini-

stration, it had to be carried through officials over whom they had practically no control. Moreover, transport and control of food movements was not a provincial subject, and the tragedy, after it had occurred, could not be staved largely due to the failure of transport system in the affected areas. In this confusion of practically no man's responsibility, we feel the main cause of the tragedy is to be found in the trusteeship system imposed on India. We do not hear of such famines in autonomous countries and do not think that the British Government could stay in office even a minute if a single man died of starvation in England. Millions died in this unfortunate land *under trust*, and what to say of Governments, even a petty officer could not be hauled up. So long as one country will remain subordinate to another, such catastrophies are likely to be repeated and the earlier this ends the better for the dependent countries and for the entire world. The fair name of Britain and her justification for the continuance of trusteeship system in India demand that those responsible for this famine, high or low, official or non-official, should be brought to trial and should be punished, if found guilty.

Long Range Measures

But simply calling it a man made famine, apportioning the blame, and punishing the criminals will not solve the eternal problem facing the millions of this vast country. There have been famines in the past, and although the incidence of full-fledged famines may now have been not so frequent, the situation as a whole has not altogether been satisfactory. In fact, India has always been on the border of famine and India's malnutrition is proverbial. Mere public philanthrophy, Government relief measures, famine commissions, voluminous reports and soothing words will not fill the stomachs of starving millions.

After Effects

Although the first onslaught of the famine is over, it has inflicted a deep wound on the entire population and its after-effects, like the effect of a fresh cut, are becoming increasingly manifest every day. It is not very far from truth to say that it has with one stroke paralyzed the nation for at least two generations. The famine is continuing to this day in a less acute form and millions of people are receiving food which is both quantitatively and qualitatively deficient. There is an all round premature ageing of the population. The effect on the health of the younger generation which will form the future nation has been particularly disastrous, as it is known that some of the nutritional deficiencies occurring during the period of adolescence can never be made good by giving a complete diet after the attainment of maturity. Even now protective foodstuffs, particularly milk, are not available to what are called the vulnerable groups of the population, namely the children and expectant and nursing mothers.

Poverty—the Main Cause

It is of course well-known that ever since the foreign domination never have the people of India enjoyed diets providing sufficient nutrition. The poverty to which the vast masses of the population of India have been reduced to is indicated by the fact that the average annual income per head has been computed to be of the order of Rs. 65. Even this average is rather high by inclusion in its calculation the income of rich people. The average income of the common masses of India is still lower. It has been shown by Sir John Orr in England as well as by investigators in this country that the nutritional level of the people tends to run *pari pasu* with the income level. Recent investigations have shown that by accepted nutritional standards more than half the population of the United Kingdom and the United States of America are not at an optimum nutritional level. Where stands India then!

There is something inherently wrong with the entire system in India; though an agricultural country, the tragedy is that she cannot even produce food sufficient for her population. With a population of about 400 millions, India, according to the report, produces about 45 million tons of chief cereals—rice, wheat, jowar, bajra, etc., *i.e.* about 3 maunds per head per annum, 10 seers per month or about 5 chattakhs (10 oz.) per day. This ten ounces cannot even physically fill the stomachic cavity of a human being. The production of fruits, milk and other nutritious products is extremely low and they are not within the reach of more than 10 per cent of the population. There is a large number of people who may not have tasted milk other than that of their mother. In other countries such as the U. S. A., the U.S.S.R. the average food production both from land and animals in quantity and quality is much higher. The Indian soils have been continuously starving for proper manures and an energetic drive for the application of artificial manures has been the most pressing need.

With the decay of handcraft in the country, thanks to *Trusteeship Rule* the percentage of population depending on agriculture has been continuously increasing thereby reducing the income and consequently the purchasing power and standard of living. The Famine Commission of 1880 had made a clear reference to this effect. In spite of there being agricultural departments both in the Provinces and at the Centre, the yield of crops has not increased materially.

In other advanced countries, the population on agricultural profession forms a minor part whereas in India about eighty per cent of the population works and lives on agricultural income which, in view of the inefficient methods of production, is very low. The balance of agricultural economy is hopelessly unstable. The methods of food production and of manuring the soils are primitive.

There is another unfortunate aspect from which India suffers and that is the confusion amongst our leaders regarding industrialization of this country and the application of scientific methods. The hollowness of sixteenth century philosophy of *back to the land and to the bullock cart* which is an obsession with some of our leaders is completely exposed and let it be realized that insistence on the efficacy of old worn-out methods will only help to hinder the progress of India and will inevitably lead us to self-extinction. A bold lead is needed to stamp out this ignorance and self-deception. Such a lead can only be given by a *Government of the People* whose sole aim would be public welfare and all-round prosperity.

Famine is a dreadful calamity, but such occurrences do give rise to searching enquiries and in free countries to the consequent adoption of drastic steps. Properly interpreted, the present calamity has revealed the tragedy of colonial administration.

Even if the causes were found, and some radical recommendations were made, they would be kept in cold storage on the usual plea of lack of funds.

If India is to be saved from the dangers of recurring famines the Government of India should seriously consider ways and means to give effect to the following measures:

(1) Industrialization of the country with the consequent lowering of load on the agricultural profession thus effecting a proper balance between industry and agriculture. The aim of industrialization should be to clearly increase the per capita income of the *masses* and not merely to increase the already rolling wealth of a few, in other words *socialized industrialization*.

(2) Creation of a permanent Food Department—The food problem in India is an eternal one and there are so many aspects such as production, transport, storage, processing, etc., that only a unified policy directed by a single Department can be effective. The Department should have a Scientific Advisory Committee with the same functions as that under the British Government, but the Government of India should see that the Executive implements such advice as loyally as the British Executive has done.

(3) Establishment of an Institute of Food Technology* which should make provision for the study of food processing, transport, storage, food statistics, etc.

(4) Immediate introduction of modern methods of agriculture, education of the farmers in these methods, aid to the farmers in the procurement of proper seeds, machinery, implements, loans, cheap power for irrigation, subsidy, etc.

(5) Speeding up of the plans for the production and distribution of artificial manures—without this, the terribly low overall production per acre which is about ¼th of that obtained in other countries, can not be improved.

(6) Immediate setting up of machineries like the TVA for the full scale utilization of water resources of the country.

These are only some of the important steps which should be immediately taken up if the country is to be saved from such disasters. We feel that a Government which assigns to itself the duties of trusteeship of such a vast country, should see that the food and nutritional situation in the country is improved and improved rapidly in the light of scientific advice.

* We learn that the Government of India are considering the establishment of such an organization. If the report be correct, it is a move in the right direction.

UTILIZATION OF ELECTRICAL ENERGY IN INDIA

N. C. SAHA,

ELECTRO-TECHNOLOGY DEPARTMENT, INDIAN INSTITUTE OF SCIENCE, BANGALORE

WHEN Boulton presented the model of the steam engine of his partner James Watt to the then King of England, he had said with his characteristic witticism, "Sire, I give you power". Little had he realized the dynamic truth behind his statement or little did he dream that in the course of a century that mechanical power would prove to be the most deciding factor in peace as well as in war. Indeed the mechanical power has become to-day the most powerful weapon at the disposal of man in his combat against the scourges of 'poverty, ignorance, dirt, and disease'.

Of all forms of mechanical power, electrical power, because of convenience, cleanliness, flexibility, and ease of transmission, has found the most universal use. The present era is really more than an electric age, for never before in the whole history of mankind has one single commodity affected the basic structure of the human society in such a profound way as has electricity to-day.

The National Planning Committee of India realizing the importance of the electrical power development recommended an increase of 100 units per capita in the production of electric energy. By the standards of the Western countries and America some of which produce over 2000 units per capita, this indeed is a meagre amount. But many of us nurtured in an atmosphere of the 17th century A.D., with our minds dwelling fondly on the glories of the 7th century B.C., cannot comprehend the utilization of 40,000 million units of energy in such a vast country as India. The object of the present article will be to draw a tentative balance sheet of the consumption of 40,000 million units in the light of the experience of other progressive countries, particularly Russia. This is to show merely the broad outlines on which to plan the consumption of electric energy in India.

In many respects the present state of India resembles that of Tsarist Russia, specially in its economic and industrial backwardness. The Soviet Government dragged the country out of the morass by a vigorous policy of industrialization with particular emphasis on electrification. The prodigious development of the Russian industry is to a very large extent due to the judiciously planned consumption of electrical energy for industrial and domestic purposes. The structure of the electricity consumption in Russia may, therefore, be taken as a suitable basis of discussion for the construction of the same for India.

The following table gives the main heads of electricity consumption in Russia in 1932 (last year of the first five year plan) and 1937 (last year of the second five year plan) and the blue print of the same for India as envisaged by the author.

TABLE 1

ELECTRICITY CONSUMPTION BALANCE SHEET

	Russ				India (Blue-print	
	in 1932		in 1937			
	(*Billion units*)	%	(*Billion units*)	%	(*Billion units*)	%
A. Industry						
(*i*) Electrical Drive	8·5	63·0	19·8	52·0	20·0	50·0
(*ii*) Electro-technological process	0·7	5·7	6·2	16·5	6·0	15·0
B. Transportation	0·3	1·9	1·6	4·2	2·0	5·0
C Agriculture .. .	0·1	0·6	0·8	2·1	1·5	3·7
D. Municipal services and Domestic uses	2·2	16·3	4·1	10·7	5·0	12·5
E. Electrical losses and station uses	1·7	12·5	5·5	14·5	5·5	13·8
Total	13·5	100·0	38·0	100·0	40·0	100·0

It will be seen that it is only in one respect that the Indian balance sheet differs from that of Russia, *e.g.* in the increase in the allocation of electrical energy to agriculture. As agriculture will play a vital role in future India, rejuvenation of archaic methods of agriculture, as practised to-day, on scientific lines by the infusion of electrical and mechanical power is essential. Of particular importance is the

execution of vast schemes of irrigation by electricity driven pumps as outlined by Stampe a few months ago. We can no longer be content with our ineffectual prayers to the inexorable Monsoon during the fatal days of drought ; we must plan agriculture in such a fashion that when God disposes, farmer can propose.

We shall now proceed to the allocation of energy to the various sub-heads under the above main heads.

Electrical Drive.—India has at last awakened to the realization that industry alone can create prosperity. But industry without power cannot produce the edifice of stable economic structure, it can at best create a cottage exposed to the merciless storm of foreign mass production. Again, industrialization is not merely mechanization ; it is today synonymous with electrification. Therefore, industry must have priority in the consumption of electrical energy. The following table gives the consumption of energy by electrical drive by the various branches of industry in Russia in 1934 and the deduced figures for India. As the question of mechanization of peat industry does not arise in India, the percentage allocation of energy to the fuel industry has been greatly reduced. In other respects, there is no material change.

TABLE 2

ELECTRIFICATION OF INDUSTRIAL DRIVE

Industry	Russia		India		Final product
	(*Million kwh.*)	%	(*Million kwh.*)	%	
1. Fuel	1896	15·0	1000	5	Coal, oil-refining.
2. Ore Mining ...	389	3·1	1000	5	Iron ore—Manganese, etc
3. Iron and Steel ...	1669	13·1	2600	13	Nil
4. Non-Ferrous Metals ..	320	2·5	800	4	Smelting & refining of non-ferrous metals
5. Metalworking ..	2607	20·6	4200	21	Machinery manufacture & metal products
6. Chemicals	800	6·3	1600	8	Heavy chemicals organic synthesis, wood distillation
7. Mined chemicals ...	69	0·5	200	1	Minerals for chemicals, electrical building industries
8. Rubber and Asbestos ...	131	1·0	200	1	Nil
9. Mined Building material	518	4·1	1200	6	Cement, firebrick, building brick
10. Woodworking ..	409	3·2	600	3	Nil
11. Textiles	1384	10·9	2400	12	Cotton, wool, silk, linen
12. Shoe and Leather ..	125	1·0	200	1	Leather, shoes
13. Paper	649	5·1	1200	6	Paper, printing
14. Food	581	4·6	1000	5	Sugar, vegetable oil, meat, canning, flour etc.
15. Miscellaneous ...	1148	9·0	1800	9	Nil
Total	12686	100	20000	100	

Electro-technological process.—As the details of the Russian industries in this respect are not available, we shall draw up the requirements from an analysis of the American electro-chemical and electro-metallurgical industries of the year 1936. The table below gives figures :

TABLE 3

ELECTRO-TECHNOLOGICAL PROCESS

Principal product	U. S. A. (1936)		India
	Million kwh.	%	*Million kwh.*
1. Aluminium	2,217	22·2	1,320
2. Copper	283	2·8	170
3. Zinc	446	4·5	100
4. Cadmium	3	0·03	–
5. Magnesium	35	0·4	100
6. Chlorine & Caustic soda ...	1,375	13·8	825
7. Electric Furnace steel ...	743	7·4	440
8. Electric Furnace Ferro alloys	1,669	16·7	1,000
9. Brass & other non-ferrous alloys	149	1·5	90
10. Artificial abrasives ...	65	0·7	45
11. Calcium carbide ...	524	5·3	310
12. Carbon and Graphite ...	162	1·6	100
13. Electric Furnace iron ...	105	1·0	70
14. Heat treatment ...	2,200	22·1	1320
15. Miscellaneous		–	110
Total	9,976	100	6,000

Electro-chemical industries now play a vital role in the national life. According to the figures of 1936, American electro-chemical industries consumed 10 per cent of the total energy generated, while, according

to the recent statement of the President of the American Electro-chemical Society, the percentage figure for U. S. A. and Canada increased to 20 per cent and the actual energy consumption to the colossal figure of 60 billion units in 1944. These statistical figures not only show the vast practical importance of electro-technological processes but also their rapid growth. Yet in India we have not a single place where facilities for the study of the subject are available!

Transportation.—Increase in production alone will not relieve the distress in India. The spectre of famine will continue to threaten India until renovation of the system of distribution and improvement in communications take place. Electricity can play a significant part in this respect.

If the electrification of some of the railway trunk lines is not a practical proposition at the present juncture, that of some of the important suburban lines must receive immediate attention. This together with the introduction of electric trolley buses will considerably improve the chaotic transport in some of the big cities. Also wireless and wire communication is in need of far-reaching expansion, if it is to carry out effective propaganda so essential for the execution of planned economy and broad education of the people.

Agriculture.—In Russia and America considerable amount of energy is consumed in livestock raising, poultry breeding, machine and tractor stations, irrigation, etc. The major portion of the quota of electric energy allotted to agriculture in India may be spent in irrigation. This will not only increase the quality and quantity of the agricultural produce of the country, but may also prove to be a suitable channel for the introduction of electricity to villages and their cottage industries.

Whatever may be the difference between the Bombay plan and the Gandhian plan, both agree that cottage industries must play an important part in the economic reconstruction of India, particularly in its initial phases. This is necessitated by the shortage of capital on one hand and the need for provision of employment to the teeming millions of India on the other hand. Introduction of electricity to cottage industries will greatly relieve the mechanical drudgery associated with many cottage industries.

Municipal services and Domestic uses.—Those who consider that the recommendations of the National Planning Committee on generation of electrical energy as extravagant will note that under planned consumption of electrical energy an individual will be allotted only 10 units annually for his domestic use or in other words a family of five members will be allowed to consume only 12 units per quarter. This clearly shows the very modest nature of the target the Planning Committee set before the country from consideration of the shortage of capital at its disposal.

Concluding Remarks

Free from the fog of high finance, wealth of a country consists of its natural resources and the mechanical and man-power to shape these to satisfy human needs. India fortunately is blessed with a fair abundance of raw materials. What we need primarily is the development of power and human skill to put them into the service of the nation. Since power to-day is synonymous with electrical power, it is the first and foremost duty of the nation to develop electric power. Therein lies the keynote to the economic generation of the country.

Will India continue to live in sloth, poverty and tradition, or will she plan for an era of power, progress and prosperity?

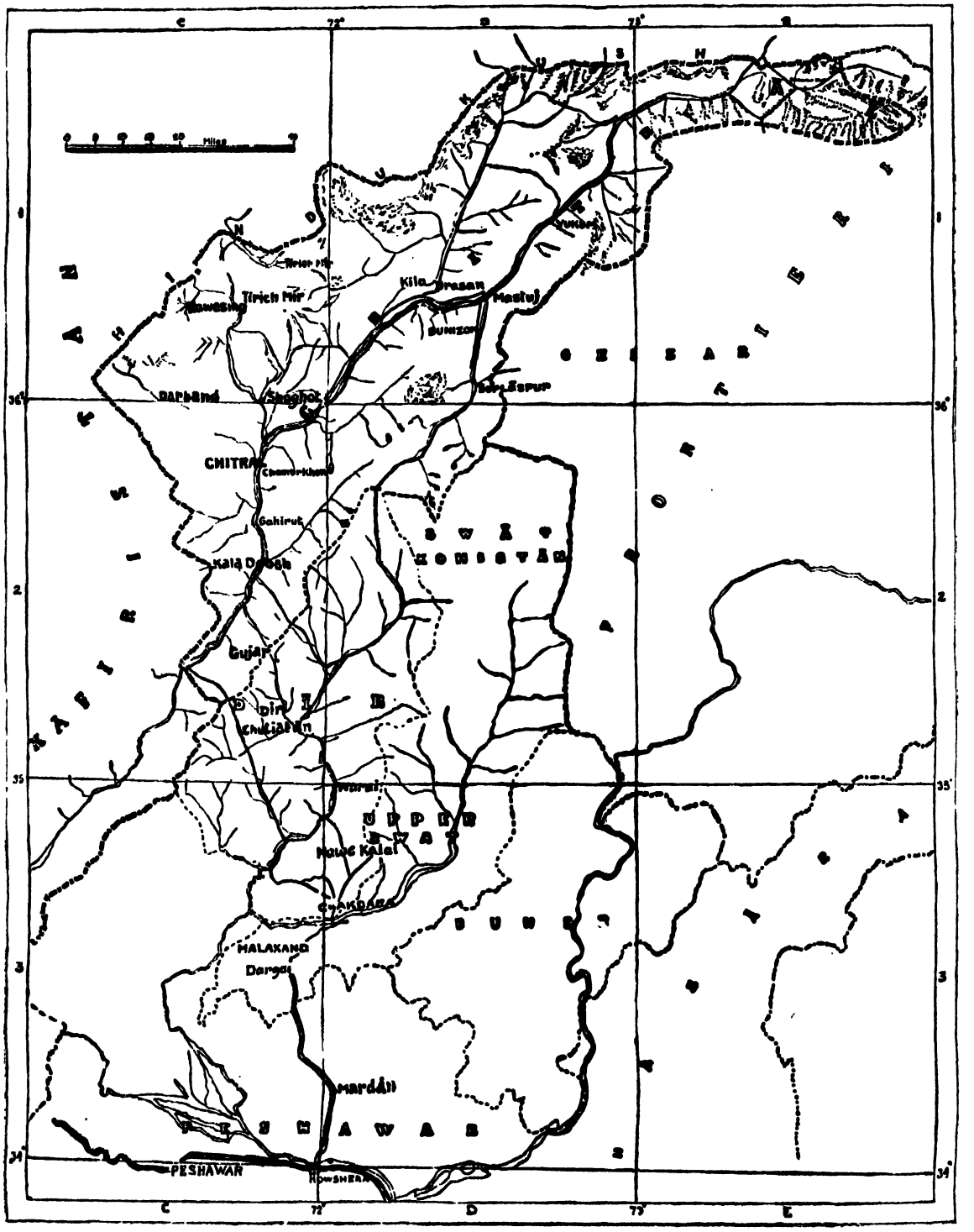
MEDICINAL PLANTS IN CHITRAL STATE

S. C. DATTA,

INDUSTRIAL SECTION, INDIAN MUSEUM, CALCUTTA

MEDICINAL plants of India constitute a very important part of Indian vegetation. With the cessation of import of medicines due to war, the importance of Indian medicinal plants have considerably increased and efforts are being launched in every direction for the cultivation of such plants. It is not generally known how abundantly some of the most important medicinal plants grow in deep forest regions and in the heights of the Himalayas. It would indeed be a very satisfactory achievement if the cultivator's attempts are supplemented by the explorer's excursions.

About a couple of years back the writer, with a view to studying the medicinal plants that grow in the Himalayan tracts and in the Hindu Kush range, undertook a journey to the heart of the forests in Chitral in the N. W. F. Province and was delighted to see how profusely some of the very important medicinal plants flourished there. The State possesses varied climates and soils favourable



Map of Chitral State.

for the cultivation of a number of medicinal plants, and, in writer's opinion, the introduction of a number of foreign plants will also come to a success in that place. A brief sketch of the journey is given below along with a report of some of the important plants that were collected there.

The State of Chitral is situated in the North-West Frontier Province at the foot of the Hindu Kush Range at about 72° E longitude and 36° N latitude. The journey was undertaken in the month of October, and as a result most of the annual plants that thrive there during the summer season could not be collected in the fresh condition. However, an idea of a number of several such plants was obtained from a collection of dry specimens which the writer obtained from local drug dealers and from other domiciled people through the courtesy of the rulers of the State.

There is no direct railway communication with Chitral. From Lahore one can go to Nowshera, a station just before Peshawar, by the Frontier Mail, and from Nowshera to Dargai by a branch line. Dargai is the last railway station in the direction of Chitral, and further journey had, therefore, to be made by bus, motor car and other conveyance. At Dargai I boarded a bus and reached Dir at the fall of dusk, where I passed the night in a Levy post. Next morning I started for Chitral on horse back. The horses were kindly sent by His Highness the Mehtar of Chitral, and it was a very pleasant journey. I crossed the Lowari pass (10,450 ft.) at noon and reached Ziarat in the afternoon. At Ziarat I was informed that a motor car was waiting for me at Asrat, a place 6 miles off Ziarat and I at once set off in a hurry as it was getting dusk. The car took me to Drosh where I had a very warm and ever-remembering reception from the Governor of Drosh. The next morning I started for Chitral in the car, after lunch and reached there in an hour's time. On the whole, I required about 6 days to reach Chitral from Calcutta.

Collections of specimens in areas up to Dir had not been possible for me as I had no passport for that and after I entered Chitral area at a place Gujar, which is the boundary of Dir and Chitral, that I started on my work of collection.

The Lowari pass have some fine forests in its neighbourhood containing chiefly *Pinus excelsa* Wall., *Abies webbiana* Lindl., *Quercus ilex* L., *Picea morinda* Link and *Juniperus macrópoda* Boiss., *Pyrus lanata* D. Don, *Prunus* sp., *Potentilla* sp., *Valeriana Hardwickii* Wall., *V. wallichii* DC, *Achillea millefolium* L., *Thymus serpyllum* L., *Rumex acetosa* L., *Aconitum* sp and *Anaphalis cuneifolia* h.f. Other plants noted in this area are, *Asplenium* sp., *Verbascum thapsus* L., *Onosma* sp., *Cynoglossum* sp., *Taraxacum officinale* Wigg., *Primula denticulata* Sm., *P. stuartii* Wall., *Inula obtusifolia* Ker., *Saxifraga* sp., *Sisymbrium* sp. and *Corydalis* sp.

Pinus excelsa Wall. dominates in Gujar and Ziarat valley along with Juniperus and Quercus. The dominant plants in the Gujar valley are *Mentha, Chenopodium, Thymus, Leonurus, Ranunculus muricatus* L., *Artemisia, Primulas, Anagallis, Salvia, Abies,' Picea morinda Link. Orchids* and *Juncus.* Other plants are *Secale* sp., *Agrostis alba* L., *Stipa barbata* Desf., *Lilium, Valeriana, Cotoneaster, Crataegus oxyacantha* L., *Clematis* and *Geranium.*

In the Ziarat valley, the common trees are, *Quercus dilatata* Lindl., *Q. ilex* L., *Abies webbiana* Lindl., *Juglans regia* L., *Pyrus* and *Prunus.* The others plants noted in this area are species of *Mentha, Amaranthus, Teucrium, Scutellaria, Delphinium, Aconitum, Chenopodium, Dioscorea, Orchids, Lilium Pimpinella, Epilobium hirsutum* L., *Potentilla, Rubus, Lathyrus, Vicia, Dianthus, Stellaria, Geranium* and *Euonymus.*

Species of *Artemisia* and *Mentha* dominates in the Drosh area along with several species of *Amaranthus, Clematis grata* Wall., *Cleome viscosa* L., *Verbascum thapsus* L., *Boerhaavia repens* L., *Achyranthes, Cyperus rotundus* L., *Panicum crus-galli* L. *Erianthus, Aristida cyanantha* Steud. *Euphorbia, Polygonum, Juglans regia* L., *Verbena officinalis* L., *Plectranthus rugosus* Wall., *Anisomeles ovata* Br., *Euphorbia, Cannabis sativa* L., *Urtica dioica* L., *Juglans regia* L., *Ammania baccifera* L., *Punica granatum* L., *Epilobium, Statice cabulica* Boiss., *Olea, Siegesbeckia orientalis* L., *Daucus carota* L., *Rubus, Rosa, Astragalus, Psoralea, Polygala sibirica* L. and other species.

I reached Chitral in the afternoon of the 6th day of my journey and passed the next day there to make preparations for my tour. The people of Chitral are very nice-looking and healthy and they have a language of their own, called Chitrali language. Urdu is more dominant here and I came into acquaintance with a number of people who understood it. Here, I also met with a few people who could understand English language. His Highness the Mehtar of Chitral is a well educated person, can compose good poems in Persian, and has refined artistic tastes. The customs of the place are after the ancient Moghuls and the ruler has a big 'Harem' where he keeps his Begums (wives) numbering about three dozen.

Tours were made to several places of the State making the town of Chitral as the centre. On the day after arrival, a journey was made to Bronshal. The plants characteristic of that place are *Pistacia cabulica* Stocks., *Statice cabulica* Boiss., *Chenopodium botrys* L., *Quercus ilex* L., and other plants which are more or less similar to the plants collected in the Drosh area. Different species of Artemisia

together with *Punica granatum* L. and *Salix* also grow there in profusion.

Harankot and Sadok were the next two places where I went on the following day. The plants which characterize Harankot are several species of *Artemisia* of which *A. scoparia* W. & K., *Salix alba* L., *Punica granatum* L., *Eleagnus* sp., *Equisetum* sp., *Cleome viscosa* L., *Rubus ellipticus* Sm. along with species of *Panicum* and other grasses. Sadok also possesses species of *Salix, Mentha, Medicago sativa* L. and others along with *Verbascum thapsus* L., *Heliotropium eichwaldii* Stend., *Setaria glauca* Beauv., *Cotoneaster microphylla* Wall. and *Cotoneaster nummularia* Fisch. & Mey.

After these I made a general survey along the skirts of Chitral. Here among the trees, I found *Platanus orientalis* (Chenar) which is cultivated for its rich foliage which afford a good shade. *Juglans regia* L. (Akhrot) is also cultivated to a large extent for the nuts as well as for timber. Other cultivated plants are *Pyrus malus* L. (Apple), *Pyrus communis* L. (Pear), *Prunus* (Almond), *Vitis* (Grapes), *Morus* (Mulberry), *Salix* (Willow) etc. *Saussurea lappa* C. B. Clarke (Kuth) is cultivated on a large scale as it has an export market there. *Brassica juncea*, Coss., *Nicotiana rustica* L., *Solanum nigrum* L., *Plantago major* L., *Epilobium hirsutum* L., *Trifolium* Sp., *Eutrema primulaefolium* H.f. & T. are also common. In addition the following plants were found to be the common features of Chitral and its neighbouring place,—*Hordeum, Eragrostis, Andropogon halepensis* Brot., *Setaria glauca* Beauv., *Adiantum, Cannabis sativa* L., *Verbascum thapsus* L., *Sesamum indicum* L. (cultivated), *Solanum xanthocarpum* Schr & Wendl., *Datura stramonium* L., *Onosma echioides* L., *Cuscuta, Cichorium intybus* L., *Artemisia* (very common), *Loniccra, Blumea, Daucus carota* L. *Thalictrum, Anemone biflora* DC., *Cleome viscosa* L., *Viola, Gypsophila, Oxalis corniculata* L., *Rosa, Pyrus, Punica granatum., Cucumis, Luffa, Phaseolus, Vigna, Medicago, Vitis* and *Pistacia integerrima* Stew.

Having obtained a general idea of the plants of Chitral proper and its bordering areas, I next started for further journey towards Tirichmir, a place about 40 miles from Chitral. The journey had to be done on horses, mules and donkeys as they were the only means of conveyances. Most of the days during our journey we had to live on boiled eggs or roasted meat as rice or bread could not always be procured. On the way I halted at Shogot and made some collections from that area and its neighbouring border. By the side of the tract leading to Shogot *Cimicifuga* grows in abundance and occasional stray plants of Polygala are often noticed. *Artemisia* is the dominant feature. Several Leguminoseae also characterize these parts. *Ephedra* and *Equisetum* were found growing plentifully on the side of the stream passing through Shogot. Shogot has a rich vegetation of *Tamarix* along with *Eleagnus, Artemesia, Glycyrrhiza glabra* L., *Impatiens, Daphne oleoides* Schr., *Viola patrini* Ging., *Clematis orientalis* L., *Capparis* sp., *Spiraea sorbifolia* L. etc. *Cuscuta reflexa* Roxb. is a prominent feature on many plants of this area.

Next to Shogot I visited Garamchasma (a place having hot water spring) which lies at a very high elevation. The neighbouring hills are found to be covered with snow and the place is very cold. A hot water spring flows here and the water smells of sulphur. The plants in this part are *Juglans regia* which grows here in profusion, *Pyrus, Prunus,* and *Vitis* (cultivated), together with *Salix* and *Litsaea. Cannabis sativa* L. is cultivated here for its leaves. There are other plants such as *Setaria glauca* Beauv., *Juniperus macropoda* Boiss., *Epilobium roseum,* Schr., *Portulaca oleracea* L., *Berberis umbellata* Wall., *Crataegus oxyacantha* L., *Malva rotundifolia* L., *Abutilon indicum* Sw., *Amoora rohituka* W. & A. and *Trifolium repens* L.

After my return from Garamchasma, I visited Birmolast (summer residence of the Mehtar of Chitral). *Litsaea, Eleagnus* and *Astragalus* dominates here along with *Ephedra, Nicotiana* (cultivated), *Polygonum hydropiper* L., *Epilobium hirsutum* L., *Cicer arietinum* L., *Cotoneaster nummularia* Fisch. & Mey., *Malva rotundifolia* and others.

Tours were also made to several other places near the skirts of Chitral, and the vegetation of those places closely resemble the vegetation of Chitral as stated above. As I already stated, I visited Chitral in October and found most of the plants drying up with the advent of winter. I learnt that with the fall of snow in December all the hills became barren. May is the proper season when collection should be made and then only it is possible to have a good idea of the complete flora of the locality.

However, on the whole I had a fair collection of fresh as well as dry specimens. Among the plants of medicinal importance, the following were collected, —*Artemisia, Astragalus* (Gum Tragacanth), *Aconitum* (dry samples obtained), *Rheum* (rhubarb) *Glycyrrhiza* (Jasthi madhu), *Datura stramonium* L., *Cannabis, Juniperus, Saussurea lappa* C. B. Clarke (Kuth), *Mentha, Psoralea corylifolia* L., *Hyoscyamus, Ephedra, Plantago, Berberis, Podophyllum emodi* Wall., *Cimicifuga, Ferula, Colchicum luteum* Baker., *Picrorhiza kurroa* Royle ex Benth., *Atropa acuminata* Royle (Indian belladonna), *Thymus serpyllum.*, L., *Valeriana wallichii* DC., *Taraxacum officinale* Wigg. and *Polygala* sp. Some of these plants grow plentifully but others are somewhat scarce. There is a great possibility of successful cultivation of these drugs in the Chitral as the State possesses varied

range of altitudes and climates necessary for the successful growing of these medicinal plants. There are further possibilities of introducing some foreign plants such as Cinchona, Pyrethrum, Ipecac, Ergot and some others as there are places in the State where the soil and climate will favour the growth of these plants.

In conclusion, I must give my thanks to His Highness the Mehtar of Chitral for giving me all facilities for my investigation and journey, but for which I could not have proceeded a single step. I also owe my gratitude to the Governor of Drosh, with whom I passed three nights during my journey. He proved to be the most useful guide and a sincere friend, always ready to co-operate in all matters and thus really he had helped me a great deal in the progress of my work. I am also thankful to Indian Herbalist Co. of Calcutta, who kindly supplied me some funds required for my journey and to Mr S. N. Bal, Curator, Industrial Section, Indian Museum, who had kindly supplied me with all necessary instructions for my journey and collection of specimens.

BLOOD GROUPING AND ITS UTILITY*

J. N. BHATTACHARJI,
CALCUTTA.

Individuality of Blood

SINCE time immemorial the individuality of cell organisms has attracted attention. We know that no two animals and no two plants are exactly alike. Some of the characteristic qualities of blood depend on the 'constitution', others upon the 'condition' of the body. The sum-total of these two factors make up the *individuality of the blood*. Blood is the common organic medium into which are poured the products of the metabolism of all the cells of the body and where they blend with each other and with the specific endocrene secretions, the balance of which is now admitted to be a purely individual phenomenon depending on inherited constitution. Iso-reactions are now considered to be the most characteristically individual phenomena connected with the blood and, therefore, hereditary and constitutional. Individuality of blood in the strict sense of the term means the constitutional peculiarities of the blood which enable us to distinguish between individuals of the same species.

The constitutional nature of the individual differences of the blood has been emphasized by the discovery that the substances which characterise the four blood groups are present in practically every tissue of the body and has been found in soluble forms in the serum, saliva and urine.

The manifold applications of blood group in biology, in clinical and legal medicine prove that it is not merely of academic interest. Its application for the selection of blood donors has made blood transfusion a safe procedure and has undoubtedly saved thousands of lives. In forensic medicine this knowledge has been applied for the identification of bloodstains and for the determination of non-paternity. Blood grouping tests may not only help to acquit the innocent but also to convict the guilty. Data on serological properties in various human races and in primates are of value to anthropology and contribute to the knowledge of biochemical evolution. Its contribution to serology has been to increase our understanding of the nature of the cellular antigens. The subject is of interest not only to the immunologist but also to the physician, the lawyer, the geneticist and the anthropologist.

* Read before the Anthropological Society, Calcutta University, on 17-3-43 by the writer, the then Officiating Imperial Serologist and Chemical Examiner to the Govt. of India.

Agglutination

Agglutinins are antibodies that possess the power of causing bacteria, red blood corpuscles, some protozoa suspended in a fluid to adhere and form clumps which settle leaving a clear supernatant fluid (agglutination reaction).

The phenomenon of agglutination is an immunological phenomenon. It is an antigen-antibody reaction, antigen being colloidal, mostly protein in nature and the antibody present in serum globulins. The agglutination of red blood cells is known as haemagglutination and agglutination of red blood cells by the serum of the same species is known as iso-haemagglutination. The antigen in the red cells is known as an agglutinogen and the antibody in the serum as an agglutinin. The agglutinogens in human blood groups are iso-haemagglutinogens and the corresponding agglutinins are iso-haemagglutinins.

Physico-chemical reaction of Iso-agglutination.—Iso-agglutination is a special case of flocculation of a colloidal suspension. There are two stages in the reaction—(*i*) fixation of the antibody (agglutinins) to the cells (agglutinogens) causing a change in the

cells, (*ii*) coming together of the cells—precipitated by the addition of traces of electrolytes (salts). How this occurs? It is generally conceded that suspension of colloid particles (red cells) maintain a balanced equilibrium by (*i*) repellent action of the like electrical charges, (*ii*) force of attraction owing to surface tension, cohesive force, etc., and (*iii*) Brownian movement which prevents gravitation. The electrolyte (salts) decreases the potential difference between the bacterial cell and the surrounding medium to below a critical value and so allows them to come together and cohere. Presence of electrolytes in suspension reduces the potential but does not reduce the cohesive force to an appreciable degree. So agglutination of particles occurs as force of attraction is greater than the force of repulsion.

Isohaemagglutination.—(Agglutination of red cells by the serum of the same species). The antigen in the red cells are known as isoagglutinogens A and B and the antibodies in the serum are isoagglutinins *a* and *b*. Groups are named after the agglutinogens of r.b.c. Immune substances responsible for the reactions are (*i*) two isoagglutinins *a* and *b* in sera, *a* being in group B, *b* in group A, *ab* in group O and none in group AB, (*ii*) two receptors for these agglutinins, *i.e.*, agglutinogens A and *B*. The presence of two agglutinins and two agglutinogens are supported by the results of absorption experiments. Group B serum containing an agglutinin *a* is absorbed by group A and not by group B cells, and similarly the agglutinin *b* in group A serum is absorbed by group B but not by group A cells. Now when the tests are performed with group O serum containing both *a* and *b* agglutinins it will be found that A cells will remove the *a* agglutinin, B cells remove the *b* agglutinin and AB cells remove both agglutinins *a* and *b*. The lack of ability of group O cells to absorb either agglutinins corresponds to their inagglutinability by serum of any group. Isohaemagglutinins are "natural antibodies" produced in the absence of any environmental stimulus according to definite genetic laws and divide mankind into different blood groups.

There are also present iso-haemolysins and isohaemolysinogens in blood.

Agglutinogens are also found in other free cells than blood and in fixed tissue cells ; so it is better to say *cell groups* rather than *blood groups*.

Biological Axiom.—Homologous agglutinin and agglutinogen, *i.e.*, an agglutinin and its corresponding agglutinogen cannot exist together in the same blood. An equilibrium process of reciprocal binding prevents auto-agglutination.

Group AB—the serum containing no agglutinins does not agglutinate anv cells. The cells are agglutinated by the sera of groups A, B and O.

Group A—The serum containing *b* agglutinates cells of groups AB and B, the cells are agglutinated by the serum of group B and O.

FORMULA FOR BLOOD GROUPING

Group	Serum of Group AB	Serum of Group A	Serum of Group B	Serum of Group O
Cells of Group AB	0	+	+	+
Do. A	0	0	+	+
Do. B	0	+	0	+
Do. O	0	0	0	0

Group B—The serum containing *a* agglutinates the cells of groups AB and A, the cells are agglutinated by the serum of group A and O.

Group O—The serum containing *a* and *b* agglutinates the cells of groups AB, A and B, while the cells having no agglutinogens are not agglutinated by any sera.

Combinations compatible with life are shown in the following table.

Agglutinogen (in r.b.c.)	Agglutinin (in serum)	Groups: International	Jansky	Moss
O	*a* *b*	O	I	IV
A	— *b*	A	II	II
B	*a* —	B	III	III
AB	o o	AB	IV	I

Agglutinin *a* produces agglutination only of corpuscles which contain agglutinogen A ; and agglutinin *b* of corpuscles which contain agglutinogen B. Hence by using group A and B cells and sera any individual can be grouped.

BLOOD GROUPING AND TRANSFUSION PROBLEMS

Blood group has a high interest in transfusion problem as it affects the integrity of a donor's r.b.c. in the blood stream of the recipient. Cells of group O not containing any agglutinogen will not be agglutinated by any of the sera and hence group O is the *universal donor*. Cells of universal donor are compatible with all other bloods but the serum is not. The serum gets diluted in recipient's plasma where there is great excess of agglutinable cells which fix the agglutinin without agglutination. Transfused serum thus loses its agglutinating power by dilution in recipient's blood, 10% of their former titre (500 c.c. to 5,000 c.c.). The titres of these agglutinating sera being usually low (1 in 30), the dilution is believed in large measure to prevent the occurrence of serious reactions. The donor's serum may have particularly high agglutinating titre and produce serious symptoms in recipient's, specially if the red count is low.

Serum of group O subjects may vary in iso-agglutination titre not only in different persons but also in same person at different times. Also there is occasional presence of minor iso-agglutinins and iso-agglutinogens. Some sera which contain *a* and *b* agglutinins also contain the corresponding *a* and *b* isolysins which act upon certain corpuscles. The extremely powerful titre of *a* and *b* is only found (1 in 26) in O groups. Such O groups can give rise to ill or even fatal effects. In O isolysin *a* is more powerful than *b*, so there is a great risk in giving O blood in A. For practical purposes, safe universal donors are those whose sera in a dilution of 1 in 16 do not agglutinate cells A and B.

Universal O donor—(*i*) if *a* and *b* are low—emergency (safe) universal donor for all.

(*ii*) if *a* and *b* are high—dangerous for all others, only good for the same group.

(*iii*) if *a* is high, dangerous for A and AB, safe for B and O.

(*iv*) if *b* is high dangerous for B and AB, safe for A and O.

Universal recipient AB Serum of AB contains no agglutinins and does not agglutinate any cells. The cells are agglutinated by the sera of groups A, B and O and exhibit variations in direct matching showing relative agglutinability. The titre of *a* and *b* of A, B and O donors should also conform to the standard as in safe universal donors before use for universal recipients. As a rule the titre of *a* and *b* is lower in B and A subjects than in O subjects. Quantitatively iso-agglutination phenomenon depends on two variables, *i.e.*, iso-agglutinin titre and relative iso-agglutinability. Group O cannot thus be injected to AB with impunity.

Transfusion in universal recipient AB—AB safest, then A, then B and O (most unsafe).*

Survival period of r.b.c. in recipient is 30 to 100 days, except in certain diseases, such as T.B., haemolytic jaundice, etc.

The New Rh Factor of Human Blood

Rh factor has been detected in some human erythrocytes (Landsteiner and Wiener, 1940) by testing human cells containing it for agglutination with anti-rhesus sera. About 85% of human erythrocytes of all the different groups and types are agglutinated by the anti-rhesus sera and as such they are Rh positive. The rest are Rh negative. The red blood cells of the rhesus monkeys are injected into rabbits or guinea-pigs to prepare the anti-rhesus sera. The anti-Rh is more commonly formed in an Rh negative woman becoming pregnant with a baby having Rh positive cells as in cases of Erythroblastosis foetalis (oedema of foetus, icterus gravis neonatarum and anaemia of the new born). The Rh factor seems to be equally distributed in the two sexes. Unlike the M and N and like A and B, Rh factor functions to stimulate the formation of specific immune agglutinin in man. The Rh factor is supposed to explain the haemolytic reactions even after transfusions with otherwise compatible blood. The antibody may be found in the serum of recipients having haemolytic transfusion reactions due to Rh and also in some pregnant women. It is therefore suggested that the compatibility tests of blood by groups, types and Rh factor of both recipients and donors should be done as a routine to safe-guard against the obvious ills. The Rh antigens and anti-bodies seem to have very useful application in clinical medicine.

Individual Incompatibility—Administration of even 10 c.c. of incompatible blood intervenously may cause severe shock, collapse or even death. It is best to use the donors of the same group, if possible, in view of the existence of dangerous universal donors. Compatibility tests are essential. Direct matching of blood between donors and recipients is advisable in view of the possible occurrence of exceptional atypical agglutinins and donors with unusually high agglutinin titre. It also serves as a check for the grouping. Grouping is also necessary as in cases of weak agglutinins incompatibility may escape attention in the direct matching test.

Technique—It is useful to have sera with a selective action, so that they will only act upon either antigen A or B. It is better to obtain sera and cells from A and B groups for test purposes not from occasional donors but from persons who are in daily contact with the investigator, *i.e.*, the investigator himself, his assistants, colleagues and other close associates. An 'individual blood catalogue' can thus be drawn up which may prove extremely useful for future investigations. We can then do without stock sera, since we have only to call upon these test persons whenever we need them and can obtain from them the required known serum and corpuscles. Sera kept in refrigerator may retain their agglutinating power for a very long time (up to several years). Test sera must of course possess a high titre. They should not be less than a titre of 1 in 5 for a reaction to appear within a minute. 2% suspensions of washed red cells A and B are used for tests. Because of individual differences due to cellular constitution of blood corpuscles highly sensitive corpuscles must of course be chosen as test corpuscles. The titration of the sensitiveness of the corpuscles may be carried out by finding the limiting dilution of the agglutinating test serum. About 5 c.c. of venous

* *a* in B is more often of higher titre than *b* in A, so B comes after A in order of safety.

blood is drawn from a subject (donor or recipient), a few drops are mixed with 1 c.c. of citrated saline (1·5% citrate with normal saline) in a test tube for cells and the rest is poured into another tube for serum. Serum after separation from the clot should be inactivated in water bath at a temperatrre of 56°C for ½ hour, as 1/5th of agglutinating sera are haemolytic and as such they obscure agglutination. There are a number of simple methods by which grouping can be done, the simplest being the slide method. One or two drops of known A and B sera respectively from capillary pipettes are mixed on a slide with an equal number of drops of a 2% suspension of the unknown cells to be grouped on the two ends of the slides previously marked with glass pencils. Similarly one or two drops of known 2% suspension of A and B cells respectively from capillary pipettes are mixed on a slide with an equal number of drops of the unknown sera to be grouped. Cells and sera are mixed with sterile glass rods with rounded ends. The slides are put in covered medium size petri dishes containing a wet piece of filter paper in a small watch glass. Such petri dishes serve as moist chambers to prevent evaporation and concentration of the salts. The result should be read within ½ hour.

Sub groups—Group A is further divisible into A_1, A_2 and A_3, sub-groups depending upon a full or partial affinity only for serum *a*. A blood may thus be O, A_1, A_2, A_3; B; A_1B, A_2B and A_3B (8 serological divisions). There is no significance of these sub-groups in transfusion except that they sometimes lead to error in grouping.

Sources of error in Grouping—The sources of error in grouping are (1) pseudo-agglutination, (2) variation of agglutinating titre in different subjects or in the same subject particularly in group B, (3) too thick cell, (4) haemolytic sera, (5) weak agglutination, (6) auto-agglutination (as in haemolytic jaundice, etc., (7) deteriorated stock sera, (8) sera to be tested originally weak, (9) test cells having a low agglutinogen, (10) titre of serum lowered by preservatives, (11) test sera of low agglutinins, (12) waiting too long for result by the open slide method, (13) sub-groups.

M and N System—Unrelated to the substance A and B there are M and N in r.b.c. M and N may occur together or separately but both are never absent at the same time. M, N and MN are found in all blood groups but in no way related to them (24 serological divisions). In the M-N system there is nothing corresponding to O in the A-B system. Normally there are no naturally occurring anti-substances corresponding to anti-M and anti-N iso-agglutinin in serum. So these factors do not play any role in blood grouping. The usefulness is considered for re-transfusion and determination of life of donor's cells in recipient's. Donor OM transfused in patient ON for determination of life of cells. After the first transfusion by donor M to recipient R, there is usually no reaction, but anti-M is developed. So there may be a reaction after the second transfusion by M. To avoid such dangers typing A-B groups by M-N is necessary. Direct matching test may warn against such abnormal reactions.

Heredity of blood groups—Fundamentals of Genetics

Chromosomes of cells are supposed to carry the hereditary factors. Male and female cells coalesce. The fertilized egg starts with the full number of 24 pairs of chromosomes—half of each pair being derived from one parent and half from the other. Located at certain spots on the chromosomes are genes a factor or a set of factors which determine hereditary characteristics in the zygote. Contrasting factors occupying the same spot as a pair of chromosomes are known as *allelomorphs*. They are pairs of contrasting genes which determine the inherited characteristic of an individual. One set of genes is derived from the paternal parent and the other set from the maternal parent. The *genotype*, purely a germinal make up, of an individual represents the composition of the somatic cells in terms of the paired allelomorphic genes. If the paired genes are similar, the genotype is homozygous. If the paired genes are dissimilar, the genotype is hetrozygous or *hybrid*. The *phenotype* is a term used to denote the expression of the hereditory characteristics as found in the individual, resulting from the reactions between the genotype.

Mendel's Law—When two varieties of plants differing from each other in one characteristic are crossed the hybrids preserve for the most part the peculiarity of one or the other parent and do not exhibit a blend of two. The characteristic which persists in the hybrids is called the "Dominant" that which tends to disappear the "Recessive". For instance, there is a factor for brown eyes and one for blue eyes (the brown being dominant to the blue recessive). The factor from either parent may be either brown or blue, so the resulting allelomorph may have both factors, brown or blue or one of each, in which latter case it is the dominant brown that will manifest itself.

Bernstein's Theory—This theory postulates the presence of 3 allelomorphic genes A, B and R. Blood group of an individual is determined by combination of A, B and R in a particular pair of chromosomes. The inheritance of A and B agglutinogens depends on two characters only, one gene from the father and one gene from the mother which may be dominant or recessive, genes A and B are dominant over gene R.

A and B denote the presence of the corresponding agglutinogens while R indicates their absence.

The possible combinations of these three genes arranged in pairs give rise to six different genotypes, corresponding to the four phenotypes or the blood groups :

Phenotypes	Genotypes
O	RR
A	AA, AR
B	BB, BR
AB	AB

Offspring of all possible matings between phenotypes O, A, B and AB in accordance with Bernstein's theory :—

Parents		Children		Children not possible
Phenotypes	Genotypes	Genotypes	Phenotypes	Phenotypes
O × O	RR × RR	RR	O	A, B, AB
O × A	RR × AR RR × AA	AR, RR AR	A, O	B, AB
O × B	RR × BB RR × BR	BR BR, RR	B, O	A, AB
A × A	AA × AA AR × AA AR × AR	AA AA, AR AA, AR, RR	A, O	B, AB
A × B	AA × BB AR × BB AA × BR AR × BR	AB AB, BR AB, AR AB, AR, BR, RR	O, A, B, AB	None Impossible
B × B	BB × BB BR × BB BR × BR	BB BB, BR BB, BR, RR	B, O	A, AB
O × AB	RR × AB	AR, BR	A, B	O, AB
A × AB	AA × AB AR × AB	AA, AB AA, AB, AR, BR	A, B, AB	O
B × AB	BB × AB BR × AB	BB, AB BB, AR, AB, BR	A, B, AB	O
AB × AB	AB × AB	AA, AB, BB	A, B, AB	O

This theory explains why O parent cannot have AB children and vice versa. When either parent is AB, half of the gametes of the parent must possess gene A, the other half gene B, so that a child of such a union will have at least A or B gene and cannot belong to group O. Conversely if either parent is group O, the offspring must have at least one R gene and cannot belong to group AB.

Heredity of M-N System—M and N inherited as Mendelian dominants. Their heredity probably depends upon a single pair of allelomorphic genes M and N. According to this theory only three genotypes MM, MN and NN corresponding to the three phenotypes, M, MN, and N respectively are found.

(1) Agglutinogens M and N cannot appear in the blood of a child unless present in the blood of one or both parents.

(2) A type M parent cannot have a type N child and a type N parent cannot have a type M child.

Heredity of the Rh factor—(Lansteiner & Wiener, 1941)—is explained by two allelomorphic genes—Rh and rh, Rh being dominant. If the husband's phenotype is Rh positive and that of the wife Rh negative, the infant's genotype will be Rh rh and the phenotype will be Rh positive provided the husband's genotype is Rh Rh. But if the husband's genotype is Rh and rh, the infant's phenotype will only be Rh positive in 50% of the siblings.

Medicolegal application of blood grouping in the identification of stains. In order to establish the individual diagnosis of bloodstains, two different and independent courses are open to us ; (*i*) we may investigate the specific isoagglutinating properties of the dried serum, (*ii*) we may try to determine the elective absorbing properties of the corpuscles, *i.e.* in other words, the specific isoagglutinable substances. Since as we have seen, however, the agglutinable substance is far more resistant than the agglutinins to deleterious influences, the second method may often enable us to achieve our object when the first would leave us completely stranded. The technique depends on the property of r.b.c. of absorbing agglutinins. This property is retained by the agglutinogens in the red cells of dried blood for many weeks. The dried blood is mixed with serum of graup O containing a fairly good and equal titre of *a* and *b*, incubated at 37°C for ½ hour and kept in the cold chamber overnight. The centrifuged serum is tested next day against cells A and B to determine the groups. Known controls are also put up with the unknown stains to check the irregularities of absorption. It should be remembered that the medicolegal application is a question of eliminating certain persons, rather than incriminating any particular individual, except as may be done by such eliminations.

Blood groups in criminals.—It is desirable not only to keep every criminal's finger prints but also of his blood group and M & N type. The former may be destroyed by a surgical operation but the change in the latter is not possible.

Blood groups in twins.—There are two types of twins, the uniovular type (identical twins) and the biovular type. The uniovular twins arise by the division of a single ovum, so their genotypes are identical. The biovular twins show only close relationship as in brothers and sisters. The blood groups of uniovular twins should be identical and this has been found to be the case by Dr Fischer. Dr Fischer investigated several twins, and he is of opinion that

in all cases of identical twins the blood groups were identical and in non-identical twins in 50 per cent of the cases they were the same as those found in brothers and sisters. Schiff and Verschauer have demonstrated that the genotypical identity of uniovular twins also holds for the agglutinogens M and N and the sub-groups of group A and group AB. It is to be remembered that agglutinogens of human blood are used as accessory factors for the determination of identical or non-identical twins ; colour of eyes, hair, features are the other factors corroborating the same findings.

Blood group and Sex.—No relationship has been established between blood groups and sex. Obviously genes determining the blood groups do not seem to be located in the sex chromosomes.

Blood groups and Superfecundation.—The obscure question of superfecundation may be cleared by blood grouping according to Augsberger, and thereby the real paternity determined. According to him if in twins A and B of group O mother, one father is group A or B, then there must be a second father of group B or A. If O mother gives rise to triplets of groups O, A and B respectively existence of two fathers must be assumed to establish superfecundation.

Anthropological Significance

Weiner is of opinion that the importance of blood grouping for anthropology has probably been overestimated. However, its limitations should be recognized. Thus whereas certain morphological traits, such as slanting eyes of the Mongolians, the black skin and woolly hair of the Negro, etc., clearly indicate the derivation of an individual, the presence of a particular blood group or type is not peculiar to any race. Blood grouping cannot be used as an aid in determining the racial derivation of single individuals and only yields results of significance when a sufficiently large number of individuals of the same race is available for statistical examination. Another limitation of the use of blood grouping in anthropology is that peoples of the same race have widely differing distributions of the blood groups whereas totally unrelated races may have a similar serological constitution. However, the fact that there is no selection of mates on the basis of blood groups is a distinct advantage, since this tends to make the blood group distribution of a race remain constant from generation to generation in the absence of immigration and intermarriage with other races. Where inter-marriage has occurred the amount of inter-breeding may possibly be estimated. Contradictory results have been obtained by various workers regarding the establishment of direct relationship between the blood groups and certain anthropological characters when they concern different races. The blood group is an ethno-anthropological character of the same order as variations in pigmentation or in the shape of the skull. It is conceivable that in mixed populations the diversity of racial origin may be reflected in each and all these characters. Thus, for instance, if a predominantly dolichcephalic people rich in group A (such as the Swedes), were to be invaded by a brachycephalic race abounding in group B (such as the Slavs), the resulting mixed population would appear to show a higher proportion of group A in dolichocephalic individuals. Hence both the resulting anthropological character and the distribution of blood groups would be due to racial diversity of a mixed population. This is, in fact, the explanation given by Rietz for the Swedes and by Ramanese for the Sardinians with regard to the shape of the skull. The interesting problem of the relationship, if any, between the blood groups and anthropological characters at present would seem to be still far from solved. Nevertheless the way is clear. We must go on examining in a uniform and systematic manner large masses of individuals belonging to the same country and wait for the number to become sufficiently large before drawing any conclusion. This might fairly be carried out, for instance, amongst the troops. In any case the question of the blood groups should be included in any statistical anthropological inquiry.

Racial distribution.—The Serological formula for a particular race is unconnected with Anthropological features. The blood characters correspond closely to geographical position. Based on the fact that full-blooded American Indians (O groups 84·5 per cent., Gates, 1929) and Filipinos (O group 64·7 per cent., Cabrera and Wade, 1928) seemed to be entirely of group O, and that factors A and B reach their greatest frequencies in Europe and Asia respectively, it has been assumed by most writers that the human race was originally all of group O, the factors A and B having arisen separately by later mutation. This is further borne out by the fact that all the people showing more than 50 per cent group O are is land folk or otherwise isolated. Recent studies on Eskimos (O group 80·7 per cent., Heinbecker and Pauli, 1928) further confirm this hypothesis. The nearer to Asia and Europe, the more B and less A, while the nearer to Western and Central Europe, the more A and the less B. The people of the intermediate area, *i.e.* those of the Medeterranian basin, show intermediate types. Mutual infiltration of the two biochemical races of the east and west probably produced the varying proportions of the A and B groups in various races. Ottenberg holds that it is hard to doubt that the data of anthropological investigations so far have some, although possibly a limited, bearing on racial origin and points out the need for a co-ordinated investigation, covering the whole world,

with uniform technique suggesting that in the future a study of the distribution of the subsequent agglutinogens may lead to a deeper understanding of the subject. Some definite racial influence seemingly exists, but at present the blood group test cannot be utilized to detect racial differences for medicolegal purposes. With elaboration and modification of technique, however, this may become possible in the near future. Following the recognition of the M and N agglutinogens, the sub-grouping of blood and the Rh-factor, research, present and future, may in all probability disclose results which will prove of value in the further application of blood grouping in relation to anthropological and other studies.

Blood Group in Field work.—It is suggested that field worker should have a full knowledge of the technique of the work. The headquarters with an equipped laboratory for finding out the blood group of samples of blood collected from the interior villages should be stationed at a place where ice, or if possible, electricity should be available. The field workers should carry with them a portable box containing thermos flasks packed with ice and other necessary requisites for collecting blood. The blood grouping of both red cells and sera may thus be carried out efficiently for anthropological investigations.

Blood Group in relation to Disease and Grafts.—Isoagglutination does not seem to depend on disease. Some writers are of opinion that blood groups have at least a bearing with body resistance. Sufficient data based on reliable and efficient grouping and typing of different races with special regard to herd immunity are necessary to come to any definite conclusion. Though the blood groups have some importance for tissue grafting in man they are not the only factors.

References

1. Blood Grouping in Relation to Clinical and Legal Medicine—by L. H. Snyder, 1929.
2. Individuality of the Blood in Biology and in Clinical and Forensic Medicine by Leone Lattes, 1932.
3. Recent Advances in Forensic Medicine by Sydney Smith and John Glaister, 1939.
4. Blood Groups and Blood Transfusions by A. S. Weiner, 1939.
5. Blood Transfusion by V. H. Riddell, 1939.
6. The Newer Knowledge of Bacteriology and Immunology by E. O. Jordan and I. S. Falk, Chicago, 1929.
7. Legal Medicine and Toxicology by Ganzales, Vance and Helpern, 1937.
9. Blood Groups and Types by S. D. S. Greval, *Current Science, 9,* No. 11, 1940.
10. The Use of Blood Tests in Excluding Paternity and Maternity by S. D. S. Greval, *I. M. G.*, Vol. LXXIV, No. 7, July 1939.
11. The Principles of Bacteriology and Immunity by W. W. C. Topley and G. S. Wilson, 1938.
12. Human Heredity by Baur, Fischer and Lenz, 1931.
13. Lynch, G. R. (1923-24), *Transactions of the Medicolegal Society, 18,* 65, Baillare Tindall & Cox, London.
14. *British Medical Journal*, London, Nov. 7, 1942. The clinical significance of the Rh factor by K. E. Boorman, B. E. Dodd, and R. L. Mollison.

CHINA TO HARNESS THE YANGTZE

A SUMMARY report of Mr John L. Savage's investigations on the utilization of water resources of the Yangtze, China's largest and world's fourth longest river, which has just appeared in the press,* has focussed world attention on this mighty Far Eastern river. Mr Savage is the chief designing engineer of the Bureau of Reclamation, U.S.A. and designed a large number of dams in the United States and elsewhere, including the famous Grand Coulee and the Boulder dams. Recently, it may be recalled, he visited India, China, Afghanistan and Palestine to study and report on the possible development of river resources of these countries, following a request from their governments to the U. S. State Department to loan his services. While in China, Mr Savage examined about half a dozen minor flood-control, irrigation and power projects and made intensive study of the Yangtze basin, including the deep gorges near Ichang. His computations and surveys convinced him that the river represented probably the greatest single source of water power yet untapped. In his own words, 'with the possible exception of some tributary of the Amazon, this is, beyond all question in my personal experience, the greatest single potential source of hydro power in the world to-day'.

The Topography of the River

Barring the plateau of Mongolia in the northwest and the high plateau of Yunnan in the southeast, China really consists of three great river basins, namely those of the Hwang-ho in north, the Yangtze in central, and the Si-kiang in south China. Unlike other great rivers originating in the highlands of Tibet, the Yangtze (3,400 miles) escapes to the east through a complex series of gorges and enters the Red basin of Szechwan province. The Red basin is an upland basin almost completely ringed round by

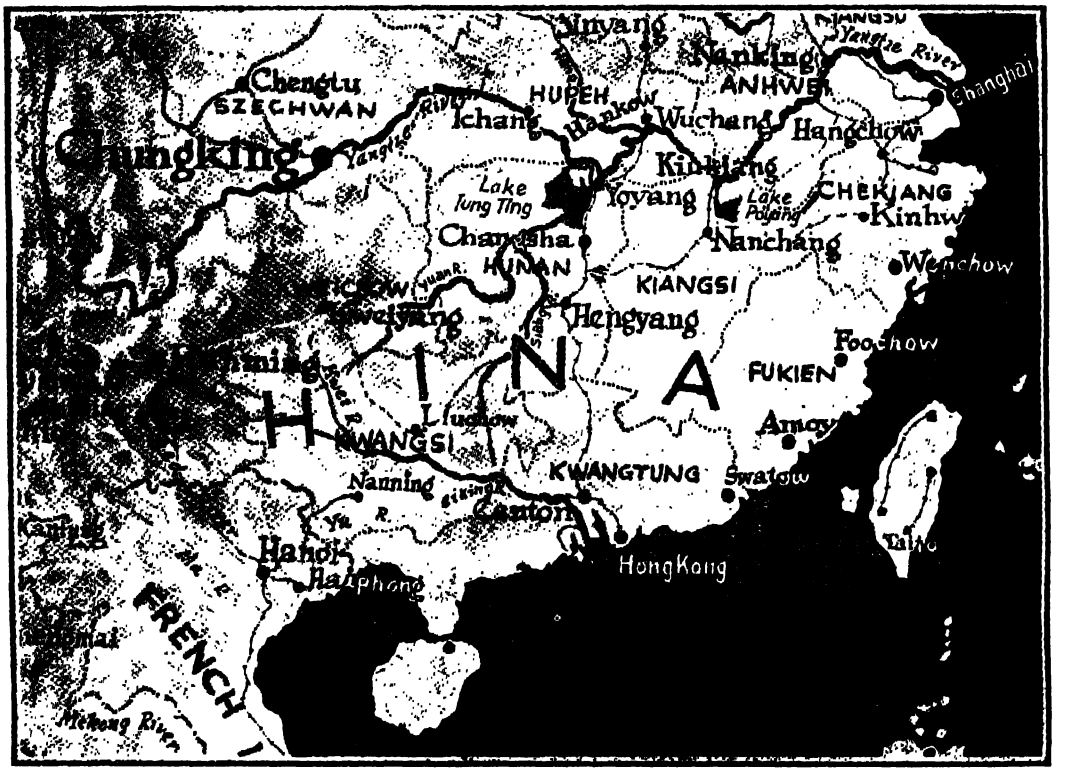
* Press report issued by the U. S. Office of War Information; China Information Bulletin, May 16, 1945.

high mountains and is highly dissected into a number of small hilly countries. The river cuts its way out of the basin through difficult mountain gorges above Ichang and pours in the lower plains of Hupeh, whence its true valley course begins. The Hupeh basin is a low land covered by alluvium and formed by the important river valleys of the Han from the north-west, the Yangtze from the west, the Yuen from the south-west, and of the Siang from the south. The river swings alternatively to the north-east and the south-east, as it passes through the north-east-south-west ridges of the eastern part of south China highlands, courses through several small basins, skirts the margin of the Po-yang basin of the Kiangsi, and finally forms its delta at Nanking.

relatively high, well distributed rainfall, seasonal rhythm of moist sub-tropical summer and mild winter and magnificent natural waterways is one of the most favoured agricultural regions in the world and the premier granery of China supporting nearly half of her total population."*

Of the mineral deposits of the valley iron is by far the most important. Numerous magnetite-haematite iron ore bodies occur along the line of the low Yangtze, just outside the Sinian môle.

Yet the river is not without its vagaries. Floods, droughts and famines which regularly visit the Yangtze basin have menaced the lives and well-beings of the people, produced frequent agrarian revolutions and have led to successive migrations of



Map showing the river Yangtze.

The Yangtze, the artery of China, drains eleven provinces, covering an area of 8,00,000 square miles, and the rich fertile alluvial deposits of its lower basins have attracted from time immemorial a veritable beehive of China's teeming millions. Mild winter and moderate rainfall, although cyclonic rains are not uncommon, favour agricultural activity almost throughout the year. A wide range of cultivated products, *e.g.*, northern cereal in winter and rice, cotton, and tea in summer, characterize the tract. "The Yangtze 'province' with rich alluvial basins, population along the river valley, which bulk so largely in the history of China. In fact, the history of China, so far as her agrarian population is concerned, is the history of her great untamed rivers which have made and marred the fortune of her people since earliest times.

Savage Plan

It is this great river that Mr Savage has planned to harness by building a dam across it near Ichang

* Encyclopaedia Britannica.

which, on account of the walls of the great gorge, forms a natural site for the purpose. The dam, when completed, will be the largest of its kind in the world, befitting the mighty river it seeks to stem. Its estimated capacity of generating about 10,560,000 kilowatts will dwarf the power output of the Grand Coulee (1,944,000 kw.), the Boulder (360,000 kw.) and the Dnieper (558,000 kw.) dams. A total of 96 generators, each having a capacity of 110,000 kw. will produce this enormous power. Mr Savage has further estimated that the waters of the tributaries may be harnessed to make available about 2,500,000 extra kilowatts. This power, when properly distributed, would serve such far flung regions as Nanking in the east, Chengtu in the west, Kweiyang and Kweilin in the south, and Taiynan in the north. The cost of power thus developed would be around 80 dollars a kilowatt, according to a conservative estimate, as against 115 dollars at Grand Coulee.

The dam which would rise to a height of 500 feet or so in the gorge would store 50 million acre-feet of water and create irrigation facilities for over a vast area of 10 million acres. By way of comparison, the Boulder dam stores only 32 million acre-feet and provides irrigation to one million acres of land. Such improved irrigation would double the food production in China whose failure to feed her population is almost traditional. The menace of floods which devastate Central China almost annually would be eliminated.

The project would react favourably on China's inland navigation. This would open regular steamer service between Shanghai and Chungking and permit 10,000-ton ships to come up to the Chinese capital, 650 miles inland.

The multi-purpose Ichang project, Mr Savage has calculated, would involve an expenditure of the order of a billion dollars. If carried out according to plan, all civil engineering work and 20 per cent of power capacity could be completed in 6 or 7 years. The financing scheme has been suggested to be a self-liquidating one ; the amount is expected to be realized in course of half a century in the shape of revenues on power, irrigation, flood-control and navigation. Afterwards the dam would pay its way by allocating half the power supply to the manufacture of fertilizer for export to the U. S. A. and other parts of the world and may yield a profit.

The implication of the power project need hardly be over-estimated. The supply of power is a pre-requisite for the development of heavy and key industries which China has failed to develop owing to political chaos and feuds within and open hostilities of imperialistic powers from without. Her present chronic poverty has been inseparable from her low consumption of electrical power. A little calculation will show that the new hydro-electric project will make available more than 250 units per head of population for consumption. The power will give China new industries and wealth to liquidate poverty, illiteracy, disease, malnutrition, and a low expectation of life, characteristic of a feudal and agrarian economy.

Chinese engineers in large numbers, we are informed, are already receiving technical and specialized training in the M.I.T. and other institutions in the U. S. A. During their recent visit to the U. S. A. and Canada, the Members of the Indian Scientific Mission came across a party of 33 Chinese engineers in the Niagra Falls. They informed the Mission that the single hydro-electric project at Ichang was 'Expected to yield as much electrical energy as is now developed in the whole of U. S. A. from hydro-electric sources (nearly 1,00,000 million units)'.

The Yangtze project, great and ambitious as it is, represents an endeavour to utilize only a part of China's water resources which are as vast as the country itself. Her second largest power dam which Mr E. P. Piper, another foreign expert, likens to the Dnieper dam, will in all probability be situated on the Tatu river of Szechwan, a tributary of the Yangtze. The fury of the great Hwang-ho or Yellow river in the north similarly requires to be tempered with man's engineering skill.

The Chinese colossus is shaking off the age-long slumber and is turning to its own untapped resources. Hardened by centuries of imperialistic aggression and exploitation and interminable wars, the proud people of the land of Confucious and Lao Tze are emerging once again as a new and vigorous oriental nation that at once inspires and fills with hope other peoples in bondage.

S. N. Sen.

SOME RECENT DISCOVERIES IN APPLIED BIOLOGY

P. MAHESHWARI,
DACCA UNIVERSITY

"GUNS and not butter"[1] may have had some merit as a war slogan in 1939, but has outlived its usefulness. "Guns *and* butter" is the present cry (for food is as important as any lethal weapon in the successful prosecution of a war), and it seems likely that a few months later it will be replaced by "*Butter* and not guns". The present scorched earth of Europe and other places will soon have to be unscorched. Gun-making will then be relegated to the background and there will be a drive for the rehabilitation and relief of the affected areas. In this the biologist will have a decisive role to play.

So many and so varied have been the discoveries of the biologist during recent years that it is difficult to do adequate justice to the subject in the space of a few pages. The best that can be done, therefore, is to call attention to such of them as are likely to appeal to the general scientist.

Plant Breeding

Coming first to the work of the plant breeder, it is well known that every species of plant has a number of more or less distinct varieties, each possessing its peculiar advantages and disadvantages. By suitable methods of hybridization the breeder could try to combine the good points and eliminate the bad ones and thus produce new varieties resulting in the saving of millions of rupees every year. But this process has got its limitations and it was soon learnt by experience that more striking results could often be obtained by crossing a cultivated variety with its wild relatives which are as a rule far more hardy and disease-resistant. The chief difficulty, however, was that the resulting offspring usually turned out to be sterile so that it could not multiply itself in the ordinary way, and the experiments were often hardly worth the trouble unless the plant could be propagated by vegetative means as in the case of the sugarcane.

An accidental discovery that a duplication of the chromosome set could make the sterile hybrid fertile, followed by another of the value of X-rays and colchicine in readily bringing about such doubling, was therefore greeted with great applause, and vast possibilities were immediately opened up for the large scale production of new species and varieties through interspecific and intergeneric crosses. Scores of such distant crosses have been made in recent years. To mention only two instances, the Russians have evolved a new grain crop—one of the most remarkable botanical achievements of the last three milleniums—by crossing wheat (*Triticum vulgare*) with rye (*Secale cereale*). The plants thus obtained have greater hardiness and higher yield combined with the ability to thrive in regions where ordinary wheat would be a failure. A still wider cross has been achieved between wheat and couch grass (*Agropyrum* sp.). The hybrids are perennial like couch grass and form a new crop excellent for grass or hay as well as grain. Some derivatives from another similar cross are frost and draught-resistant, others have a greater yield and better quality than wheat. These are also immune to rust and smut and yield a flour with a distinctive flavour.

In India the sugarcane has been crossed with a wild grass known as "kans" (*Saccharum spontaneum*), with Sorghum and with the bamboo. The hybrids with the first have already proved to be of great value and the economic possibilities of the other two are under investigation.

Physiology of Reproduction

A very interesting discovery made three years ago at Odessa was an improved method of potato propagation through the use of mere "chips" containing the eyes instead of whole tubers. This resulted in a great economy and enabled the Russians to increase their potato crop to a very large extent inspite of the severe losses in materials and territory which they suffered at that time. The advantage of the method lies not only in obtaining more plants from each tuber but in being able to save the greater part of it, which formerly rotted away in the soil, for other purposes.

An immense literature pertaining to "growth hormones" has appeared during recent years. By the proper application of some of these substances it is possible to make many plants take root from cuttings when formerly there was no way to grow them except from seed—a laborious process which does not always yield an offspring that is true to the parental type. Experiments are in progress in India and elsewhere to test their efficacy in the vegetative reproduction of a number of plants like mango, litchi, cinchona etc. An additional use of growth hormones lies in the production of seedless fruits in place of the usual type whose seeds are

[1] Since writing it, the nation which raised this cry has unconditionally surrendered.

often a great nuisance. Success has already been achieved in the case of tomatoes, peppers, brinjals, cucumbers and squash, and it is possible that before long the spraying of dilute solutions of these magic drugs on the unfolding blossoms of our fruit trees will become a standard practice in modern horticulture.

Trace Elements

An important discovery in the physiology of nutrition is the role of certain "minor" elements in plant growth. For nearly a century we have known ten elements—carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium and iron—as essential for plants. Now it has been found that there are several others which are also important, although required only in minute quantities. Of these, copper, boron, manganese and zinc are specially noteworthy. A die-back disease of citrus occurring in Florida, California, South Africa and other places has been traced to copper deficiency ; lack of boron similarly causes serious damage to apple crops ; an absence of manganese often gives rise to a chlorosis ; and zinc deficiency is known to cause a "rosette" of apples, "mottle-leaf" of citrus and "yellows" of walnuts. In all these cases, proper application of the deficient element to the soil or to the aerial parts in the form of a spray brings quick relief.

New Sources of Food

One of the benefits of war is the great impetus it gives to the sharpening of our intellects. Napoleon backed the cultivation of sugarbeet in France, when West Indian sugar was denied to him because of the blockade imposed by the English Fleet. He was subjected to much ridicule on this account and a famous cartoon was drawn showing him sweetening his coffee by dipping a beet root inside it ; yet another showed him offering it to his little son, King of Rome, with the caption, "Suck dear, suck, your father says it is sugar". Today, in spite of that derision, the sugarbeet has attained an important place in sugar manufacture and the world cannot help feeling thankful to Napoleon for his efforts in encouraging the industry.

A new example of this kind is seen in the use of such an absurd thing as grass for human food. In two pamphlets entitled "Grass for All" and "Eating for Victory", an English author describes the advantages of eating moderate quantities of young grass shoots. At the ripe age of 68 this old gentleman professes to have experienced a remarkable sense of rejuvenation, both spiritual and physical, from the use of this very unusual diet. A parallel and equally interesting discovery is the use of wood pulp as animal fooder. Although useless to man, owing to the absence of the requisite enzymes or micro-organisms in his digestive tract to effect its solution, it has been found that cattle and horses can absorb it almost entirely because their digestive organs contain certain bacteria which can break down the cellulose of the wood into products that can be absorbed into the blood. It is of course necessary to add some salts and molasses to make such diet palatable and more nutritive.

The present widespread cultivation of soya bean is a natural outcome of the critical protein situation of wartime. Many new uses have also been found for this crop. Unfortunately, however, soya protein is only a second class product not comparable with animal protein. Yeast protein is considerably superior and much nearer the mark. Now, while animals make their proteins from the small amounts of *organic* nitrogenous substances found in the grass and herbage which they consume, the yeast cell is able to do so merely from the cheap ammonium salts manufactured from the nitrogen of the air, and the carbohydrates available from molasses. One particular strain of yeast, known as *Torulopsis utilis*, has been found to be particularly suitable for this type of protein synthesis, and this discovery has been responsible for the present widespread manufacture of food yeast. A further development which is not very remote is the making of fermentable carbohydrates from wood, thus envisaging a still greater reduction in cost.

Dehydration of Food-stuffs

The safe storage and quick transport of foods is another problem that has troubled man ever since he began to crowd into cities and plan for the future. The present disturbed conditions have increased the problem a hundredfold. Owing to the difficulties of shipping, weight and bulk must be kept down to a minimum. Whole armies are moved at extremely short notices from one front to another and often to places where fresh food is impossible to secure. Paratroops and commando units which must be entirely self-sufficient when in action are put to a still greater strain in this respect. And even in the home, if one has land and labour, he can grow enough peas or cauliflowers to last for the rest of the year, provided these can be cheaply preserved in such a manner as to retain their palatability and vitamin content.

Drying, pure and simple, is the oldest known form of food preservation. Nature herself uses it, for seeds, grains and nuts contain less than 10 per cent of moisture regardless of the amount which may

have been present at the earlier stages of growth. During the war of 1914-18 substantial quantities of dehydrated vegetables were prepared in Canada and the United States and shipped to Europe for the use of the armed forces, but they were not popular and the kindest description of their flavour used to be that they resembled hay. The problem has been revived during the present war and with the increased knowledge of the behaviour of enzymes and vitamins the whole problem is now being tackled with a greater hope of success. The process comprises three steps: (*i*) careful cleaning and chopping of the material into small pieces, (*ii*) blanching the pieces in steam or boiling water, and (*iii*) placing them in the drier. The second step is of special importance. Until a few years ago, it used to be thought that the Vitamin C (ascorbic acid) in vegetables is destroyed rapidly when they are heated in the presence of air. It is now realized that it is an enzyme present in the cells which destroys the ascorbic acid when the tissues are damaged by bruising or by heat. But, if the vegetables are scalded rapidly, the enzyme is destroyed first so that the ascorbic acid remains unaffected.

Several plants for the dehydration of food stuffs have now sprung up in all parts of the world but it is difficult to make any prophecy regarding their post-war fate. Shortages of supply and the exigencies of the situation are bound to persist for a number of years even after peace has been restored. The great shortage of shipping and the crippled state of the railway system of Europe may result in a serious famine so that dehydrated food would still be valuable for at least two or three years to come, and meanwhile if the process could be perfected still further so as to ensure the palatability and nutritive value of the dehydrated product and improve its keeping qualities, the success of the industry is assured.

Animal Breeding

Turning now to the animal kingdom, we find that the achievements of the zoologist have been no less important. Birth control may be very good for the human population of certain countries, but who does not want his sheep or goats or cows to breed as rapidly as possible? Difficult though the problem may seem, it has been solved to a large extent already. Ordinarily a bull can serve a maximum of 80 to 100 cows in a year but with the modern technique of artificial insemination the same bull can fertilize ten times the number, for the greater control over the process in human hands makes it possible to employ much smaller quantities of the seminal fluid. Further, it is possible to store the sperms and to transport them by air to other countries so that a cow in England can be fertilized by a bull living in Russia, although the two are separated by several thousand miles. Experimental work is also in progress to find out ways of feeding and managing good males with a view to increase their output of semen and to extend the length of their breeding lives.

Whether anything similar can be done to increase the reproductive efficiency of the female is a question that has frequently been put and has so far presented a more difficult problem. New hopes have, however, been raised in recent years. By the administration of suitable hormones it has been found possible to bring the female into heat at a time when she would normally not be ready to receive the male. Two crops of lambs have been obtained where only one was possible in the past. Treatments have also been devised to cause the formation of more than one egg at a time so that twins and triplets may be produced by our cattle in place of the solitary young one which they normally produce. And something even more striking has been accomplished by the development of a technique by which supernumerary ova can be transplanted to the uteri of other females which would act as foster mothers from the earliest stages of the animal's development. It is claimed that by this method a dairyman would be able to obtain 10 to 20 calves per year from a single high yielding cow instead of the usual solitary one. To explain the point further, let us take the instance of a farmer who has one cow of superior breed and several inferior ones. During the period of its heat the first cow will produce a single egg ; instead of being allowed to remain in its body this could be removed from here and transplanted into an ordinary cow which could then be fertilized by natural or artificial means by sperms from a superior sire and would give birth to a calf in due time. Three weeks later the first cow would produce another egg and she would continue to do so every three weeks until she is herself allowed to become pregnant. By hormone treatment mentioned before, the number of these ova can be increased still further. By transplanting all these ova into scrub cows, the latter are made to serve as foster mothers to a large number of good calves so that in a few years the farmer can build up a herd of a much superior breed in place of the inferior type with which he had started. It thus seems certain that we shall very soon begin to use our best cows for the production of eggs rather than milk, just as we use our best bulls for sperm production rather than for ploughing or other manual labour.

Another equally remarkable discovery is the production of a fatherless offspring in the higher animals. Although accomplished several years ago in the case of frogs, attempts to imitate the process in mammals had until recently proved quite un-

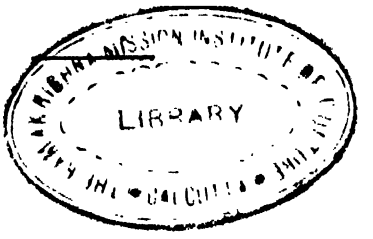
successful. About six years ago Dr. Pincus, an American Zoologist, removed some unfertilized eggs from the oviducts of rabbits and placed them in sterile glass dishes containing blood plasma or serum. He was surprised to find that out of 213 eggs so cultured 136 underwent division, so far as the 20 cell stage, but after a time they disintegrated. By activating unfertilized eggs with salt solutions and afterwards transferring them to a suitable medium, Dr Pincus succeeded, however, in obtaining living baby rabbits from mothers who were virgins in the truest sense of the word. What wonder if this is soon achieved in the case of cattle and horses and even in human beings? It would be a great boon if a particularly good cow could be made to reproduce pathenogenetically and thus give a homozygous offspring in which the chromosomes of the ovum itself would be duplicated without any other interference.

Medical Biology

Not less striking have been the achievements of the biologist in the field of medicine. The name "Penicillin" is on everyone's lips these days, but not all know that it is a plant product which has been discovered by a biologist and which no chemist has yet been able to synthesize in the laboratory. Prof. Alexander Flemming, of St. Mary's Hospital in London, accidentally noticed that a green mould (later identified as *Penicillium notatum*) growing as a contamination on his culture plates seemed to attack his colonies of staphylococci which were seen to be dissolving and disintegrating in its vicinity. Subcultures of the mould were therefore made to study its antagonistic behaviour towards other germs and soon Prof. Flemming became convinced of its marked antibacterial properties. The lapse of 12 years between the discovery of penicillin and its preparation in a form suitable for therapeutic trial was merely due to the difficulty of concentrating and purifying it.

Another life-saving device, known for many years but perfected only during and after the last war, is the practice of blood transfusion. Some time in the year 1492, Pope Innocent VIII, then of an advanced age, fell into a condition which made it impossible for those attending on him to decide whether he was alive or dead. All medical treatment proved to be useless, but one physician offered at last to heal and rejuvenate the old man if only the fresh blood of a youth was available. His proposal was at once accepted and three young men were bled to death but the Pope could not be saved. Similar experiments were tried by others on various subsequent occasions, but generally these proved to be extremely hazardous. The chief obstacles to the method were: the clotting of the blood obtained from the donor and its frequent incompatibility with that of the patient leading to serious consequences. Yet the idea was right. These difficulties have been overcome during the present century, and to-day we have banks of stored blood available for immediate use in the home, factory or field, and it can be flown by air to other places as needed. It is interesting to know that in Russia 95% of the blood is given by women and every ampoule bears the name of its girl donor. The wounded soldier thus knows to whom he is indebted for the precious fluid which gives him a new lease of life. Romances often develop between these men and their once unseen feminine saviours and are broadcast for their full propaganda value.

Other feats of biological engineering like the grafting of portions of skin, bone, nerves and arteries, the transplantation of the cornea of a man who has just died to another who is alive but blind, and the manufacture of artificial limbs etc. have been accomplished, which would have been regarded as nothing short of witchcraft in the days of our grandfathers; but of these on a later occasion. Suffice is to say that biology has its full share of thrills and discoveries which make all the difference between health and disease, life and death, and hell and heaven. If the progress in this subject, as compared with that in some other sciences, appears to the outsider like the proverbial race between the tortoise and hare, this is merely due to the fact that biological research is always a long range affair and its purpose is the saving and betterment of human lives rather than their destruction. It is a pity that the latter has usually a greater appeal to popular fancy than the former.



Notes and News

SCIENTIFIC INSTRUMENT INDUSTRY

By including 'Scientific Instruments' as a subject for overseas training, the Government of India, it appears, have recognized the significance of the manufacture of scientific instruments in this country. Successful execution of an intensive programme of scientific and industrial research in the post-war period, for which plans are being drawn up, will depend largely on the supply of better and up-to-date instruments in great abundance. Manufacture of scientific instruments is mostly unknown in this country, and barring one or two enterprising companies who have made some effort to make instruments, most others who style themselves as scientific instrument companies are mere agents of foreign manufacturers. The difficulties of these companies and their complete failure to supply instruments for teaching, research and other purposes during the present war are too well known to need mention. Our hopeless backwardness in this direction is further reflected from the fact that until recently instruments used to be sent to foreign countries for small repair work. It is futile to expect any real progress in the training of scientific workers in our universities and institutes, and for matter of that, in the broader field of research and development, until the manufacture of scientific instruments is undertaken in India in right earnest.

The establishment of this industry, we are afraid, will not be easy in the face of keen competition among foreign manufacturers for instrument markets. The rival firms of the United States, Great Britain, France, Italy, Czecho-slovakia and Switzerland, to omit Germany and Austria, in their effort to revive their trade after the war, will place real difficulties in the way of enterprising Indian manufacturers.

In an article in the *Journal of Scientific Instruments*, March, 1945, Dr Raginald S. Clay apprehends such a competition and expresses grave anxiety so far as the British scientific instrument companies are concerned. Before the war Britain lagged behind Germany and the U. S. A. in the instrument industry, and if British products still sold well in India, Canada, Australia and other parts, it was largely because of political preference. During recent years, and particularly in the present war, the United States has applied the mass-production methods in the manufacture of scientific instruments with decided advantage. Further the major firms, Dr Clay reports, have so organized themselves by voluntary agreement that a particular firm is asked to concentrate on the manufacture of a given scientific instrument. This division of manufacture among the different firms has eliminated competition between firm and firm and has made possible mass-production and a consequent reduction in price. Each firm concentrating on a single instrument is now in a position to provide greater amount of money for research and maintain better research staff and equipments. This increased provision for scientific research has assured constant improvement in design and operation.

In England, on the other hand, each scientific instrument company manufactures a variety of apparatus and, instead of continuously producing a single instrument, makes a batch at a time. This has resulted in a high price for British instrument and a low profit in the event of competition. Dr Clay suggests the reorganization of the scientific industry after the American practice and recommends the following steps: Firstly, all the firms engaged in the manufacture of each type of instrument, such as microscope, electrical measuring, navigating or surveying instruments, or lecture apparatus, should combine into a group and divide the work among themselves by mutual agreement. For instance, the construction of a complicated instrument like microscope may be very conveniently divided among a number of firms, one making students' microscope, another petrological microscopes, another metallurgical microscopes, another high-class research microscopes, while the making of objectives for all of them may be entrusted to another single firm. Secondly, each group should set up a joint selling agency which would secure orders for the group and divide them among the constituent members. Thirdly, a competent design and research staff should be established, in which the knowledge and experience of all the firms in the group should be pooled for the common benefit of all. This design staff should not only be responsible for the good design of actual instruments, but should also undertake to assist in the design of tools and machines necessary for their manufacture. A common research staff for the group and close co-operation with the Central Scientific Research Association will be very desirable.

Dr Clay has laid great emphasis on research in scientific instruments as an indispensable criterion of success for the industry. Men of high scientific calibre should be found to take charge of research, and attractive salaries should be offered to them. There will

be further need for qualified draughts-men, laboratories, and well-equipped workshops, and skilled mechanics to carry out the experiments, first as a piece of research, then on a trial basis, and finally on productive lines. Assurance to these men of an interest in any invention with which they are credited will be a great impetus for good and original work.

Although Dr Clay's suggestions directly concern the British industry, these merit close attention of the Indian manufacturers. As an appendage of Britain, we have a dangerous tendency to imitate British practice, regardless of its failure and shortcomings. In any such attempt care should be taken that their mistakes are not repeated and that full advantage is taken of their experience and difficulties.

RESEARCH EXPENDITURE IN AUSTRALIA

THE Bulletin of the Australian Association of Scientific Workers, February 15, 1945, has done well to publish figures of expenditure on scientific research in Australia. An expenditure of 0·16 per cent of national income compares favourably with the corresponding figure of 0·1 for Britain and 0·3 for the U. S. A.

To assist in the work of the Planning of Science Conference, an estimate of this expenditure was made last May by listing some 230 official and semi-official laboratories, institutes etc., and filling in the annual expenditure either (*a*) directly where it was known, (*b*) from the number of qualified workers, where known, or (*c*) by assessing their probable number where unknown. The annual cost per qualified worker of the C. S. I. R. was evaluated without difficulty. It varied between £800 for Information Section and £2,000 for Aeronautics, the mean of all workers being about £1,500. Five other laboratories gave a mean of £1,200, and it was assumed that for most laboratories having little costly equipment, or no high ratio of assistants, the cost was £1,000.

The expenditure by private industry could not be correctly estimated. Some conclusions were, however, drawn on the basis of a study of 24 large and representative companies with satisfactory provision for scientific research to their credit.

The results of investigation tabulated below will convey a better impression as to the amount expended on research in connection with a number of major branches of development.

The Bulletin further quoted figures for expenditure in Britain on certain other items such as tobacco, drink, gambling and advertising, which reflect her national characteristics. An expenditure of 3 per cent of national income on tobacco, 2 per cent on drink, 1 per cent on gambling and 2 per cent on advertising will certainly interest our readers.

Industry	Research Expenditure £ thousand: Common wealth	State etc.	Priv. Ind.	Total	Annual Value £ million	% on Research
Non-rural primary	160	6	—	27	12	0·23
Mining ..	21	33	—	48	30	0·16
Rural ..	15	228	—	388	170	0·23
Secondary ..	235	123	120	478	250	0·19
Defence ..	330	—	—	330	300	0·11
Transport, etc.	21	26	—	47	120*	0·04
Health Services	38	142	—	180	11*	1·64
Educational, etc.	15	19	—	34	17	0·20
Various ..	41	31	—	72	90*	0·08
Total	876	809	120	1,604	1,000	0·16

* Note: These figures are especially doubtful.

ENERGY AND VISION

IN his Sigma Xi National Lecture for the year 1944 on 'Energy and Vision' published in the *American Scientist*, July 1944, Dr Selig Hecht, of the Columbia University, discussed the interesting and highly puzzling question as to how bright a source of light should be in order to excite the sensation of vision. S. P. Langley was the first person to have raised this question as early as 1880 and himself undertook experiments to that end, employing a bolometer for the purpose, which he had recently invented. He found that a minimum energy of 3×10^{-9} erg was necessary for the light incident on the eye. This was equivalent to about 1000 quanta for the frequency of light used. His measurements attained considerable significance when Einstein in 1911 discovered the Photo-chemical Equivalence Law.

Langley's results were later on called in question, and more refined and accurate measurements by subsequent workers indicated a much lower value for the number of quanta responsible for the excitation of vision. This accuracy depended on certain optimum physiological conditions not taken into consideration by earlier workers. These conditions are that (1) the eye must be thoroughly dark adapted, (2) it should view a small field 10 minutes in diameter placed 20° off-centre, (3) there should be a definite exposure time, say 1/1000 of a second, and that (4) the light should have a wavelength of 510 mμ.

From their recent experiments, Hecht and his collaborators concluded that the eye should receive between 54 and 148 quanta in order to see a light of wavelength 510 mμ. These results, significant as they are, do not contain the complete solution of the mystery shrouding the mechanism of vision. All of the quanta incident upon the cornea cannot reach the retina for the obvious reason of scattering and reflection from the various parts of the eye, such as

aqueous humour, crystalline lens, vitreous humour etc., through which light must traverse. A loss by 59 per cent of the light of wavelength 510 mμ appears very reasonable, so that nearly 26 out of 54 quanta may be assumed to be finally successful in finding their way to the retina. The retina consists of the sensitive elements, namely the rods and cones, of which only the rods are concerned with the process of vision. When a quantum of light strikes any of these rods, it starts photo-chemical reactions which result in the generation of sensory impulses transmitting through the bipolar cells into the ganglion cells and through the brain to the occipital certex. And vision is produced! Clearly enough, each of the 26 quanta cannot be so fortunate as to strike a rod and be absorbed. Dr Hecht calculates that a 20 per cent retinal absorption is a very probable figure such that not more than 5 to 14 quanta are absorbed by the rods to start the events which end in our seeing light.

Dr Hecht concluded his discussion with two questions: (1) Why do we require 5 quanta, and not one, for the excitation of vision? (2) Why the human eye has been made so sensitive as to deal with single quanta when light is so plentiful? While no definite answer is available for the first, the biological law of natural selection is probably the answer to the second. 'The need for seeing other animals before they could see us for their ulterior purposes' is responsible for the increased sensitivity of our night vision. In obedience to the law of natural selection, the animals developed more and more sensitive vision, and the limit will be reached 'when a retinal rod cell is capable of being brought into action by one quantum of light'.

THE DECIMAL SYSTEM OF COINAGE

We heartily welcome the news that the Government of India are now seriously considering the question of introducing the decimal system of coinage. Under the present coinage system, the rupee is divided into 16 annas and each anna is divided into 12 pies. The proposal is that the rupee should be divided into 100 cents and not into 192 pies. The present rupee, half rupee (equal to 50 cents), and quarter rupee (equal to 25 cents) would remain, but the lower denominations would be replaced by coins of the value of 10, 5, 2 and 1 cents, with possibly also a ½ cent coin. This division has been suggested on the lines of the existing Ceylon coinage.

A communication containing the proposal has been addressed by the Government to various Chambers of Commerce. The Government suggest that immediately after the cessation of hostilities, when sufficient supplies of nickel will be available, a huge recoinage programme will have to be undertaken. This would provide a unique opportunity for any reform such as the decimalizing of the coinage system in whose favour weighty arguments always existed. The advantages of the system are so obvious that it has gradually displaced all other forms in most of the countries with the exception of Great Britain, India and certain other countries. The system offers unparalleled quickness and simplification of calculations indispensable for modern trade and commerce. Before taking any practical step the Government are keen on receiving public support which we believe will be readily forthcoming. During the difficult period of transition, however, both the system will be recognized side by side.

Welcome as this move is, this represents only a part of a much broader reform to be introduced in the present unscientific system of weights and measures in vogue in India. We have on more than one occasion drawn the attention of the Government on the urgency of this reform. The centimeter and gramme system has been universally acclaimed as the most logical and scientific system calculated to immensely simplify and facilitate commercial and other transactions. Britain's insistent adherance to the foot-and-pound system, resting largely in national pride and distinction, must not be allowed, as in the past, to stand in the way of a very desirable reform long over-due in this country.

MANUFACTURE OF FOOD YEAST IN INDIA

In his report on the manufacture of food yeast in India, Mr Nanak Chand, Special Officer, Food Department, has indicated the possibilities of producing this important food item on a large scale and at a very cheap price. A committee, with Sir S. S. Bhatnagar as Chairman, was appointed to examine to what extent the manufacture of food yeast from molasses was a practical proposition, and Mr Nanak Chand was asked to report on the best methods for the disposal of effluent from the factory and for the utilization of the manufactured product from the nutritional point of view. Their findings were that food yeast can be cheaply and profitably manufactured from surplus molasses and that, with the experience gained, there would be no difficulty in producing more than 3,000 tons of this highly nutritive stuff per annum. It is estimated that it will be available to the consumer at about 6 annas per pound. According to the report, the cheapest and easiest means of disposal of the effluent consists in discharging it into a large river or canal.

Food yeast contains, among others, high grade proteins and vitamins of the B complex, in which Indian diets, particularly of the poorer class, are deficient. Food yeast can be very easily mixed with flour and *atta*, providing additional vitamins and pro-

teins some of which are lost in wheat milling. An addition of 2 per cent food yeast does not affect the taste of bread, although the colour becomes slightly more brown. It can not be so mixed with rice at any stage of milling or cooking, but it can be cooked with curry or vegetables, mixed with spices and taken with milk or sweets so that rice-eating population may also share it without difficulty. The report recommends the introduction of food yeast for civil consumption through schools, hospitals, health and maternity centres and other such organizations.

BIOLOGY AND GENETICS

IN a symposium on the "Applications of Genetics to Plant and Animal Breeding", organized by the Genetical Society in London on April 13, 1944, Dr C. D. Darlington, President of the Society, said 'that genetic owes a debt to plant and animal breeding both for its foundation and its development. If the purpose of agriculture in the future is to be the highest production, genetics will have the opportunity of repaying the debt'.

Referring to the breeding practices, Dr Darlington pointed out that on the one hand common sense alone would sufficiently indicate the breeding programme in its initial stages. In grasses and forest trees, commercial practice favours quantity of seed rather than quality of fodder or timber. In cattle-breeding when the breed society, founded to improve cattle, has become organized to prevent improvement, artificial insemination is resorted to and no more economical and fruitful programme of genetical research could be suggested than the long-neglected survey of actual breeding practice and performances in Great Britain to-day.

On the other hand, there is the highly developed breeds of poultry and varieties of cereals where maintenance and further improvement demand a skilful combination of elaborate techniques. The statistician is necessary for design and interpretation, the cytologist for exploration and creation, geneticist for planning and direction.

In a two-day conference on "The place of Science in Industry", arranged by the Division of Social and International Relation of Science of the British Association on January 12 and 13, Dr Darlington discussed the unity and power of biology and referred to the implications of biology in the field of plant and animal breeding, of the control of diseases of crops, and of such human scourges as cancer. The teaching of biology is thirty years out of date, and that will delay the fruition of the unity and power.

Sir Harold Hartley, summing up the discussions of the conference referred to the general agreement on the need for greatly increased support for research, and particularly for more endowment by the State and for making a scientific career really attractive and giving the scientific worker full encouragement and freedom to work in the way in which he can best develop his powers. He indicated of what had been done, and how much still remained of what was possible, if we harnessed the brain power of the scientific worker to the improvement of the prosperity and welfare of the community.

INDIAN CENTRAL JUTE COMMITTEE

A REPORT of the scientific investigations carried out on jute by the above Committee for the year 1943-44 states that considerable progress was made during the year under review in agricultural research in producing selection (C. 41-KJ) that ripened 3 weeks earlier while it gave practically the same outturn of fibre as D. 154.

Colchicine induced tetraploids ($4n = 28$) resulted in the stouter appearance and larger size of the stem and petiole due to an increase in the size of the cells. The fibre of such plants was wider and its lumen almost double that in normal $2n$ plants. This holds out a promising future.

Application of nitrogenous fertilizers in deficient soils tends to reduce the length of the fibre, but this deficiency can be made good by applying potash. Potash manure proved very useful in controlling stem-rot disease.

From the observations of the last five years it is evident that the fungus is seed-borne and this depends upon the extent of the stem-rot in the mother crop and the amount of rainfall towards maturity.

Efforts were made to secure the adoption of Jute canvas for charpoys for service use. Since then the technological laboratories of the committee have been able to spin fine yarns from jute, and the possibility of manufacturing jute or jute-cotton union fabrics has been taken up in hand.

During the year under review, University schemes were carried out under the guidance of the professors-in-charge of the schemes *viz.*, X-ray analysis of jute fibre under Prof. M. N. Saha, chemical utilization of jute and jute waste and biochemical investigations on the processes involved in the retting of jute under Prof. B. C. Guha, growth and development of jute fibre under Prof. B. C. Kundu, and impregnation of bleached or delignified jute fibre with suitable synthetic resins under Prof. J. K. Chowdhury. Satisfactory progress was recorded in each of the schemes as mentioned above.

Indian Jute Mills Association are now manufacturing many speciality fabrics and new jute goods for war purposes, and the future of these depends on their price, durability and attractive appearance.

The revenue for the Jute Committee unlike that for all other commodity committees, is derived not by a jute cess but by a statutory grant from the Central Revenues, not exceeding Rs. 5 lakhs in any year. This grant is subject to the condition that they can profitably be spent in the year and naturally depends upon the financial position of the Government of India at the time.

The Committee resolved that the Government of India should provide for a non-lapsable grant of not less than Rs. 5 lakhs a year for the next five years, thereby safeguarding the position of the contract officers of the Committee.

The Committee at its meeting held in January last further decided to approach the Government of India to create a Jute Fund, to allocate to it a rupee per ton out of the existing Export Duty on Jute and Jute goods, and to place the entire proceeds of the Fund at the disposal of the Committee.

For the year 1943-44, a grant-in-aid of Rs. 50,000/- and a further grant of Rs. 40,000/- for the extension of work of the Technological Research Laboratories were received from the Government of India. Bengal Government contributed Rs. 3,745/- and Rs. 1,000/- towards the scheme for Jute Research Sub-stations and for the scheme for dissemination of jute prices respectively in Bengal.

A sum of Rs. 97,510/- and Rs. 1,54,849/- were expended for agricultural and technological researches respectively. Marketing and economic research and publicity involved an expenditure of Rs. 25,500/- and Rs. 26,246/- respectively.

Extension of the Jute Agricultural Research Laboratories at Dacca into a "Central Station" with the following sections *viz.* Botany, Chemistry, Agronomy, Entomology, and Statistics is envisaged in a comprehensive scheme accepted by the Committee. Eastablishment of five smaller "outstations" at Kishoreganj, Rangpur, Jessore, Burdwan and Chandpur are also recommended. This would involve an expenditure of Rs. 4,25,000/- non-recurring and Rs. 1,30,000/- recurring. The setting up of a Jute museum is also recommended.

The utilization sub-committee has decided for mass demonstration and circulation amongst growers, an illustrated circular on the subject of jute pests and diseases and the remedial measures devised by the Committee.

INDIAN CENTRAL COCOANUT COMMITTEE

In pursuance to an act (X of 1944) passed by the Indian Legislature that received the assent of the Governor General on the 31st March 1944, the Government of India have now constituted the Indian Cocoanut Committee consisting of the following members, with the Vice-chairman, Imperial Council of Agricultural Research as its President.

The growers of cocoanut in India are represented on this Committee by two members nominated each by the Government of Madras and the States of Travancore *viz.* Sir V. R. Nayanar, Mr A. G. Soans, and Mr S. Krishna Iyer, and Mr G. A. Baker, respectively. One each by the Governments of Bombay, Bengal, Orissa, Mysore State, and Cochin State *viz.* Mr S. K. Kallapur, Mr Sadaruddin Ahmad, Rai Bahadur Baidyanath Misra, Mr A. C. Malle Gowda, and Mr B. M. Peter respectively.

The cocoanut oil industry is represented by one member nominated by each of the Governments of Madras, Travancore State, Cochin State and Indian Merchants Association, Bombay, *viz.*, Sri Rao Sahib A. K. Menon, Mr A. R. Sulaiman Sait, Mr K. P. Madhavan Nair and Mr K. M. Antia respectively.

The Governments of Madras, Mysore State, and Travancore State are represented by the Directors of Agriculture, Madras, Mysore and the Chief Secretary to the Travancore State respectively. The Central Government is represented by the Agricultural Commissioner with the Government of India.

The Travancore and Bombay Chambers of Commerce are represented by Mr K. C. Karunakaran and Mr F. Q. Lobb respectively.

The Legislative Assembly of the Central Legislature is represented by Sir K. B. Jinaraja Hegde and Mr H. A. Sather H. Essak Sait and the Council of State is represented by the Hon'ble Mr M. Ct. M. Chidambaram Chettyar.

Mr K. R. Narayana Iyer, Mr D. D. Mallappa, and Mr M. Sankara Menon are nominated by the Governments of the States of Travancore, Mysore and Cochin respectively.

The act provides for the creation of a fund for the improvement and development of the cultivation, marketing and utilization of cocoanuts in India, to be expended by the Committee.

A cess shall be levied and collected on all copra consumed in any mill in British India, whether produced in or imported from outside British India. A duty of excise at a rate not exceeding four annas per cwt. is to be fixed by the Central Government after consulting the Committee.

The Committee shall be responsible for the improvement and development of the cultivation and marketing of cocoanuts and their utilization for the production of copra, cocoanut oil and cocoanut poocnac, (*a*) by undertaking to assist or encourage agricultural, industrial, technological and economic research, (*b*) by the supply of technical advice to growers, (*c*) by encouraging the adoption of improved methods of cultivation, (*d*) by carrying on propaganda in the interests of cocoanut industry, (*e*) by collecting statistics from growers, dealers, millers and

other sources on all relevant matters bearing on the industry, (*f*) by fixing grade standards of copra and its products, (*g*) by recommending the maximum and minimum prices to be fixed for copra, (*h*) by advice on all matters which require attention for the development of the industry, (*i*) by improving the marketing of cocoanuts in India and abroad and suggesting suitable measures to prevent unfair competition, and (*j*) by adopting any other measures which the Central Government or the Committee may think necessary in order to carry out the purposes of the act.

CENTRAL FISHERY RESEARCH INSTITUTE

Dr. Baini Prashad, as Director of the Zoological Survey of India in a memorandum entitled "Post-war Development of Indian Fisheries" recommended the formation of a Central Fishery Research Institute, on the lines similar to those of the Agricultural Research Institute at New Delhi, Veterinary Research Institute at Mukteswar and Izatnagar and the Forest Research Institute at Dehra Dun. A five-year plan for the development of fisheries in India is also detailed in this memorandum.

In their fifteen-plan involving 1000 crores of rupees, the I.C.A.R. in their "Memorandum on the development of agriculture and animal husbandry in India" (with Sir Pheroze Kharegat as its Chairman) recommended the establishment of an Indian Central Fish Committee, fisheries research stations (marine and inland) etc. It estimated a sum of Rs. 10 lakhs a year for the fish committee and a non-recurring Rs. 20 lakhs and recurring Rs. 5 lakhs a year for the Fisheries Research Station.

In the second report on Reconstruction Planning of the Reconstruction Committee of Council "Fisheries", also formed a part of their deliberations. They also concluded that a Central Fisheries Institute should be established as early as possible.

Since then the Government of India appointed a Committee with Mr Fazul Ibrahim Rahimtoola as its Chairman and with 10 other members, including Dr Baini Prashad (now employed as Fisheries Development Adviser to the Government of India) acting as Secretary of the Committee, in September last, to examine the question of India's Fisheries with a view to increasing the fish output in India.

The report of this Committee has been approved by the Policy Committee of Agriculture, Forests, and Fisheries of Government of India. Being the last of the long series of Committees and reports on fish and fisheries, it may be considered to be authoritative and conclusive. The Government of India is to be congratulated for the efficient manner in which reports on fish and fisheries have been multiplied in less than 12 months.

It is estimated by the Rahimtoola Committee that a sum of Rs. 50 lakhs will have to be provided for, for carrying out their recommendations that would include the formation of Indian Central Fish Committee and 5 fishery research institutes (2 for marine and 3 for inland fisheries). They have estimated that the total quantity of fish produced in India at present does not exceed 1,79,30,000 maunds and that is inadequate for the total population of of India.

The establishment of Fishery Research Institutes should be given effect to at once by supporting the work that is already being done at Madras with regard to marine fisheries and in the Calcutta University with the problems of estuarine and inland fisheries. The work of these institutes and similar institutes that may be established in other parts of India should be co-ordinated with the help of the Indian Central Fish Committee that should include representatives of universities and other non-official organizations as members of the fish trade. The question of rehabilitation of the fishermen should not be lost sight of and should have a priority over all other problems connected with the fisheries.

A proper development of the fish industry at one of the Indian ports, that would substantially increase the protein consumption in the country is stressed by Dr B. C. Guha, Chief Technical Adviser, Department of Food, Government of India. This would lead to the development of fish bi-product industry. India has much to learn from America in this respect where no part of the fish was wasted. Even the offal was utilized for cattle and poultry feeds after drying and scales were used for making glue.

INDIAN INSTITUTE OF ART IN INDUSTRY

The Art in Industry movement, that originated in 1941, through the enterprise of Burmah-Shell, with support of six other commercial organizations, organized 'Art in Industry Exhibition' for the last five years. The first such exhibition was held in Calcutta in 1941, and the fifth one was held early this year in Bombay (see Science and Culture, January, 1945).

After five years of pioneering work, a permanent All-India body *viz.* the "Indian Institute of Art in Industry" was registered in Calcutta recently. This body has taken over all work in connection with Art in Industry movement in India.

The objects of this Institute is to guide by all practical means the development of commercial art and industrial design and to encourage traditional handicrafts. It will serve as a link between artists and designers and industrialists, business men and citizens, organize art in industry exhibition, build

up a permanent collection of outstanding examples of Indian applied art and act as a centre of information on all aspects of art applied to industry. Research into public taste, advanced training for teachers, exchange of information with other countries, publication of journals and bulletins, organization of clubs and libraries are some of the other aspects of the institutes' activities. Compilation of a register of commercial artists and designers and to put them in touch with trade and industry will be an useful task to be performed by this institute.

It is understood that five experts in applied art will be brought from abroad, to foster the institute's activities. The institute will require a revenue of Rs. 5½ lakhs a year and support is expected from Central and Provincial Governments, States, and from industrialists all over the country.

The institute is expected to prove very useful during the period of post-war reconstruction and expansion, in harnessing the artistic talent in the country and applying such knowledge for the sake of industry.

PRESERVATION OF FRUIT IN U. K. AND U. S. A.

DURING his recent tour, Dr B. C. Guha, Chief Technical Adviser, Department of food, Government of India, said that because of its size and enormous food production, America was the most advanced country in food technology, where there were many different types of dehydrating plants in use and the largest factory was manufacturing 17 tons of dehydrated cabbage per day as against an average of 1 to 2 tons of potatoes in an Indian factory.

Fruit industry had a great future in India, provided, it was placed on scientific and economic lines during the war. During the 20 years great advances had taken place in refrigeration in America. Refrigeration was undoubtedly a better method of preservation than canning or dehydration, with regard to the retention of the original quality of the foodstuff but it required a large organization from the factory to suitable warehouses, to store the refrigerated products.

Referring to the distribution of milk to "priority" consumers in England, Dr Guha pleaded for the introduction of similar scheme in India, where he felt that under the present emergent conditions, healthy adults should be entitled to milk only after the needs of children and expectant and nursing mothers had been satisfied.

Dr Guha further stressed for the adoption of a more scientific food and nutrition policy for India, as has been done in England and attended with great success.

The Government of India, have since then appointed a Committee of scientists with Sir S. S. Bhatnagar as Chairman, Dr B. C. Guha as secretary and Drs. W. R. Aykroyd, H. S. Pruthi, D. N. Bahl, M. Damodaran, Bashir Ahmad, V. Subrahmanyan, G. Sankaran, K. A. Hamid, Major Fisher of Q. M. G.'s Branch, Lt.-Col. C. V. Ramchandani, Sarder Bahadur Lal Singh, Fruit Development Adviser and Mr D. R. Sethi, Agricultural Production Adviser, Government of India as members to tender advice on the scientific, nutritional and agricultural aspects of the processed food industry in India. The Committee will help in the switch over of the industry from war to peace time conditions and aid in its development in the interests of better nutrition and agriculture.

BALLISTIC WORK OF RUPTURE OF TWISTED BUNDLES OF JUTE FIBRE

IN memoir No. 5 (Technological Research) of the Indian Central Jute Committee, Messrs. B. K. Chakrabarti, K. R. Sen and C. R. Nodder, describe a method of measuring the ballistic work of rupture of bundles of fibre into which any desired degree of twist has been inserted. The pamphlet is illustrated with a goodbrand ballistic yarn tester, that is used for this purpose with suitable attachments. With twisted bundles the variation of work of rupture with twist is much the same as the variation of the strength of yarns with twist. The results are derived with 15 samples of jute covering a wide range of fibre qualities and these tests will help in predicting what will be the strength of yarn spun from similar fibre. This method (twisted bundle) has special advantages that would help to increase the usefulness and precision of the measurement.

The method would further give precise information regarding the spinning quality of the fibre and therefore prove useful in grading work.

DR H. K. SEN DEAD

We deeply regret to announce the death of Dr Hemendra Kumar Sen, Director of Industries, Bihar, at his Calcutta residence on Sunday, the 3rd June, 1945. A full account of his eventful life and career will appear in our next issue.

SCIENCE IN INDUSTRY

MINERAL FERTILIZERS WITH SPECIAL REFERENCE TO THE SOIL OF BENGAL

DURING the proceedings of the United Nations' Food Conference at Hotsprings, very important and far-reaching decisions of great interest to the people of India have been taken. Sir Pheroze Kharegat who represented India at the conference has drawn our attention to this most important resolutions that have been adopted, specially with reference to the use of fertilizers in this country, the need of manufacturing them in India and the possibility of starting industries for which the necessary machineries and technical skill could be obtained from the U. S. A. and the U. K. An intensive programme of industrial production of synthetic fertilizers is the first step towards raising crop-yield to meet the present and the future food requirements of the people. Accordingly, the Government of India finally decided to invite a Technical Mission from U. K. to advise on the production of artificial fertilizers in India. Headed by Mr G. S. Cowing of I.C.I., the Mission toured round India for selection of places for the establishment of the factory. The Mission also recommended that ammonium sulphate should be manufactured in this country by the well-known Haber-Bosch synthetic process and gypsum should be used in place of sulphuric acid as is done in the works of the Imperial Chemical Industries in Bellingham, England as the place for erecting the plant. The Mission, however, recommended Harduagunj, near Aligarh. A heated controversy followed the submission of the report of these foreign experts; fortunately, however, the final selection of place for the establishment of the first factory was unanimously decided at Sindri, near Dhanbad. Here the Government of India will manufacture 3,50,000 tons of ammonium sulphate per year. The question which naturally strikes our mind is how much this chemical fertilizer will be useful to develop and increase the crop of Bengal. At present only 26,000 tons of ammonium sulphate are being annually produced in this country in the different by-product recovery plants in Jharia and Giridih coal-fields and 76,000 tons are being imported. They are mostly used by tea-planters in Assam and Bengal and a part of it is being utilized by the coffee and tobacco cultivation in South India.

A very important research work carried out at the University College of Science, Calcutta by one of our colleagues on the effect of phosphorus deficiency on growth and nitrogen metabolism in paddy cultivation has proved that the absorption of nitrogen is dependent on the supply of phosphorus. As the external concentration of phosphorus is varied over a wide range, the uptake of nitrogen by the rice-crop varies in the same sense. Thus the uptake of nitrogen is found to depend on phosphorus concentration, the greatest uptake being associated with the highest phosphorus level. The research shows that in the heavy soil of Bengal, where there is a definite phosphorus deficiency, the addition of nitrogenous fertilizers like ammonium sulphate or ammonium nitrate would not be of great help to improve the quality of rice or jute crop, and the expectation of an yield of increased output by the addition of this synthetic chemical fertilizer is far from satisfactory.

In Travancore State, where the soil is rich in phosphorus, the addition of ammonium sulphate for the paddy cultivation proved to be very satisfactory. Travancore sands contain monazite which is a phosphate of rare elements and is derived from the pegmatite associated with charnockite rocks occurring in the neighbourhood of Travancore State. Therefore, the soil of the State is equally rich in phosphate, and nitrogen metabolism in the soil is favoured by the presence of this element when synthetic nitrogenous fertilizer is added to the soil. So the problem which faces our province is to enrich the soil of Bengal with phosphorus before the application of ammonium sulphate as a fertilizer.

There are two important phosphate deposits in India—one at Trichinopoly in South India where there is a rich nodule phosphate deposit and another not very far from Calcutta, within 150 miles from Calcutta, in Singhbhum district. The mineral is known as Apatite—calcium phosphate with chlorine or fluorine. This mineral contains about 25 to 30 per cent of P_2O_5. The most conservative estimation of the quantity of material available in some of the three known localities has given us a very encouraging figure. The minimum figure is about 700,000 tons of this mineral containing 25 to 30 per cent of P_2O_5. The treatment of these phosphates and their use form a subject of research which should be attractive to some industrialists in this country. Nothing has been done in this line, either to find out more ore reserve or to find out a convenient economic method to manufacture superphosphate from this mineral, which is absolutely necessary for the soil of Bengal.

There are other sources of phosphorus also available, particularly from animal bone, but we can not expect a large quantity of this product considering the paucity of bones available and the big demand of

phosphate fertilizers necessary for our Bengal soil. Sea-water may be considered to be another source of not only phosphate rock but also of various other materials. It has been calculated that the sewage from 5 million people is equivalent to 17,000 tons rock phosphate per year. The population of Great Britain discards as sewage the equivalent of 150,000 tons of rock phosphate, most of which reaches the sea. An estimate of the annual losses of phosphate from all possible sources to the sea in the U. S. A. amounts to an equivalent of 60 million tons of rock. We have no idea about our Indian losses in phosphate. Researches should be done in this line to recover this important rock-phosphate from sea-water and other important minerals from sea-water. The Salt Department of Travancore State is successfully separating gypsum from their salt pans and is capable of producing a fair tonnage per year. No such effort has yet been done in this province or in Orissa where there are many salt-manufacturing concerns near the sea. Marine gypsum when recovered from sea-water in part may be utilized in the Sindri factory at Dhanbad, where gypsum will have to be transported either from the Punjab or from Rajputana.

S. D.

GAMMEXANE—A NEW INSECTICIDE

THE Imperial Chemical Industries have recently developed a new insecticide, called gammexane, which is claimed to have remarkable toxicity against a wide range of insect pests including locusts, weevils, mosquitoes and house-flies. The story of the development of gammexane and its insecticidal properties have been recently told by Dr Roland Slade, while he delivered his Hurter Memorial Lecture before the Liverpool section of the Society of Chemical Industry, of which a summary has appeared in *The Chemical Age*, March 17, 1943.

The new insecticide is a sample of 1.2.3.4.5.6. hexachlorocyclohexane (benzene hexachloride), briefly known as "666" from its formula $C_6H_6Cl_6$. The compound was made in 1942 by F.D. Leicester, a veteran chemist of the I.C.I.'s Widnes Laboratory, and tested for its insecticidal action by F. J. D. Thomas with promising results. Later on when pure specimens of the various isomers of 666 were prepared and separately tested with a view to ascertaining which particular isomer was really the active agent, γ-isomer was found to be mainly responsible for the insecticidal action of the compound. The α- and β-isomers were relatively non-toxic, β-isomer being practically inactive. Dr Slade has suggested the name 'gammexane' for the γ-isomer of 1.2.3.4.5.6. hexachlorocyclohexane, which is the active principle of 666 and is present to the extent of 10-12 per cent in the crude material.

Insecticidal preparations containing 666 have been produced in the form of powder, solution, emulsion, etc. The powder contains 20 per cent crude 666 and 80 per cent gypsum and can be used on crops. 5 per cent solutions of gammexane have been prepared by dissolving it in suitable solvents which include methanol, xylene, carbon tetrachloride, perchlorethylene, and decahydronaphthalene. These may be further diluted for use with kerosene or other suitable oil. Staple emulsion for use in the field has been produced by preparing a concentrated solution with an emulsifying agent, for instance selected Turkey Red oil, and then adding water.

The great stability of gammexane to high temperatures has made possible its application in the form of smoke. Such smokes may be evolved by volatilization from hot plates or by other heating methods. The use of an insecticide in the form of a smoke has the advantage that it can be directly applied against insects and, by giving rise to a toxic film on walls, etc., can successfully attack insects alighting on them.

Gammexane acts both as stomach and contact poison and also can be used as a fumigant. The nature of the interference of insecticides with the life processes of the cell is still largely unknown. It is believed, Dr Slade pointed out, that gammexane is probably absorbed from outside of the insect and is distributed throughout some portion of the organism to the cells, blocking a vital reaction and ultimately causing the organism to perish.

GLYCYRRHIZIN

GLYCYRRHIZIN is the sweet principle of the licorice plant which is a leguminous shrub growing to a height of several feet. In his 26th Streatfield Memorial Lecture to the Royal Institute of Chemistry, Dr P. A. Houseman (*Discovery*, October, 1941) revealed that it was the sweetest compound available in Nature, being 50 times as sweet as cane sugar. Its sweetness is detectable even at a dilution of 1 part in 20,000 parts.

The plant is grown in Spain, the Near East and other places. Glycyrrhizin content of roots from the Near East varies from 10 to 14 per cent, whereas the Spanish root does not contain more than 6 to 8 per cent of the sweet principle. The plant bears bluish flowers, sends down a tap root and develops a thicket of runners. The runners are usually very long, sometimes exceeding 25 feet, and thus play an important part in carrying on propagation, as enough runners are left behind when the root is dug out.

The extraction of glycyrrhizin from licorice is a

simple process. Roots are ground and treated with hot water, when the sweet compound appears in solution and can be obtained by evaporation of the solution. A satisfactory chemical formula for glycyrrhizin remains yet to be determined. Tobacco manufacturers, and not confectioners, are reported to be the largest consumer of the world's supply of licorice extract. Its use in the tobacco industry has been favoured because tobacco products to which glycyrrhizin has been added do not dry out readily.

THE PLASTIC INDUSTRY

B. S. GIDVANI,

ACTING DIRECTOR, LONDON SHELLAC RESEARCH BUREAU

DURING the past twenty-five years of the current century, an entirely new kind of synthetic material has been added to that small group of substances known as *Plastics*. These materials are so striking in their properties and capabilities that they have succeeded to a large extent in replacing natural materials for certain applications.

Plastics are materials, other than Plaster of Paris, clay or glass, which at some stage of their manufacture are in a soft condition, permitting their being moulded into any desired shape. Until the end of the last World War, these were limited to lac, pitch, asphalt, casein, celluloid and rubber. All these materials could, under heat and/or pressure, be given any desired shape or form. Lac was mainly used for gramophone records ; pitch and asphalt for battery cases ; casein for buttons, buckles and other ornaments ; celluloid for combs, dolls, toys ; and rubber for various articles. Their use was, however, limited due to certain inherent defects such as lack of strength of shellac, inflammability of celluloid and so on.

The chemical technology is so well advanced that it is now possible to produce materials with any desired properties. Synthetic materials free from the inherent defects of the natural substances have been produced, increasing the scope of their employment in various industries. Some of these synthetic plastic materials are as strong as steel, hard and tough, almost unbreakable, and are unaffected by atmosphere, acids and alkalis. Others are so resistant to flame, heat and electricity as to approach mica in these properties. These plastics can be moulded into any shape or form by either a simple casting or by heat and pressure in a die and can also be produced in sheet or tube form of great strength. They can be sawn, drilled and worked on a lathe like any metal.

Others are produced in almost every known colour, some transparent like glass but unbreakable, and others translucent. Their range of application is varied and wide.

Plastics are generally classified in two groups, *viz.*, thermoplastics and thermosetting materials. The former group includes those materials which can be softened, moulded or shaped by pressure with or without the application of heat, retaining their new shape on cooling and releasing the pressure, but which if desired can be *repeatedly resoftened by heat and remoulded*. The process of moulding is thus *reversible*. The thermosetting plastics, in their original condition, can also be deformed by heat and pressure but in this case the action is *irreversible i.e.*, once in their finished shape or "cured", they *cannot be resoftened or remoulded*. This final moulded shape remains rigid and hard when heated and carbonizes when a certain temperature is exceeded.

The best known, belonging to each group are :

Thermo-plastics.—Cellulose, Bitumen, Casein, Polystyrene resins, Polyvinyl resins, Polyacrylic resins, Polyethane resins, Synthetic rubbers.

Thermo-setting.—Phenol-formaldehyde resins, Urea-formaldehyde resins, Melamine-formaldehyde resins, Glyceryl-phthalates.

The rapidity with which the plastic industry has developed is revealed by the astonishing number of new plastic materials produced during the present century. Milestones in the progress are :—1909, discovery of phenol-formaldehyde resins by Dr Backeland ; 1914, industrial use of cellulose acetate, particularly as a dope for stiffening fabric of aircraft wings ; although cellulose acetate had been known for several years, it was not until the production of aircraft dopes, that this ester was manufactured in quantity, which in turn led to its use in many other fields including the production of artificial silk ; 1924, urea-formaldehyde resins discovered by a Viennese chemist named Pollak, which were first marketed as substitutes for glass but were too costly to compete with the ordinary glass ; 1935, discovery of acrylic resins which are optically almost perfect and have completely replaced ordinary glass in aircrafts ; 1937, production of polyvinyl resins from natural and cracked petroleum gases ; 1940, production of nylon which is considered to have immense

possibilities in the post-war days, particularly in the textile industry.

The growth of the plastic industry has been as rapid as that of the industries with which it is associated—the electrical, radio, automobile and aeronautical industries. The electric industry has been almost transformed by these new materials and nowadays almost every electric instrument or appliance contains one or more parts fabricated out of plastics. The rapid development and improvements in the automobile and aeronautical industries have been to a great extent due to the plastic industry. Since plastics are generally much lighter than metals, they are particularly suitable for such applications where high stresses are not likely to be encountered. Plastic materials are being increasingly used to enhance comfort and pleasure of travelling. No motor car or aeroplane in the modern practice is manufactured without several of its parts made from plastics. Even such a conservative branch of transport as the British Railways employ them to a great extent. The "Coronation Scot" which was considered as the finest piece of railway engineering and the 1939 London *Tube* Trains made extensive use of plastic materials.

Plastics have brought a beauty, colour, and a new form of art to life which had not been possible before—an art which is not merely imitative but original and creative as to be considered a worthy addition to the art materials of old.

The ramifications of the plastic industries are varied and wide. Many industries, although using large quantities of plastics, maintain an identity of their own, examples being grinding wheels, brake lining, plywood, printing inks, paints, varnishes and lacquers, sandpaper, glues etc.

The penetration of plastic materials in the engineering industry has progressed rapidly, not only for constructional work such as tanks for holding corrosive liquids, but for pipes, pumps, gears and bearings that have been found to outlast the toughest steel.

The plastic industry is subdivided into 3 sections namely, (1) manufacture of synthetic resins, (2) production of plastic materials in the form of moulding powders, sheets, tubes, laminated boards etc., and (3) moulding and fabricating the plastics into the required finished articles.

The third section is really a purely engineering industry, although some synthetic resin manufacturers mould finished articles and some moulding firms make their own resins. But generally the moulding industry purchases sheets, tubes, powders, etc.

The heavy engineering industry is naturally closely associated with, and has played a vital part in, the development of the plastic moulding industry by designing and developing moulding presses etc. Designing of moulds is a specialized industry but many large moulders have a separate department for this purpose.

Just as the backbone of the steel industry is the manufacture of ingots, so the backbone of the plastic industry is the production of synthetic resins. The most important basic raw materials from which these synthetic resins are produced are (1) coal, (2) lime, (3) petroleum, (4) cellulosic materials including cotton and wood and (5) proteins such as milk casein and soya bean.

From coal are obtained coke, benzol, toluol, phenol, cresols, cumarone, indene, styrene etc. Coke on heating with lime gives calcium carbide which with water yields acetylene, an important starting material for synthesizing a number of plastic materials of the vinyl type. Calcium carbide can also be converted into calcium cyanamide from which urea and melamine are obtained.

Petroleum gases on cracking are converted from paraffins to corresponding olefines, and by suitably controlling the process butadiene is obtained. Butadiene is the most important starting material for manufacture of synthetic rubbers. Vinyl compounds can also be produced from petroleum gases, for example ethane is converted to ethylene which on chlorination gives ethylene dichloride. Vinyl chloride is obtained from the latter compound by treatment with alcoholic potash.

Formaldehyde, an essential material for production of some synthetic resins, is obtained by oxidation of methyl alcohol. Methyl alcohol may be obtained either by distillation of wood or by heating "water gas" with a catalyst at 300-400°C under a pressure of 200 atmospheres. Formaldehyde when evaporated with ammonia solution gives hexamethylene tetramine, commonly called hexamine, which is used as an intermediate in the manufacture of formaldehyde resins.

Acetic acid and its anhydride which are required for the production of cellulose acetate are obtained by the pyrolysis of wood. Acetic acid may also be produced by fermentation of molasses or may be synthesized by heating a mixture of formaldehyde and carbon monoxide at high temperatures and pressures or by passing acetylene through dilute sulphuric acid containing a mercury catalyst.

It is thus clear that successful development of the plastic industry depends upon a flourishing chemical industry. The basic raw materials are all available in India in sufficiently large quantities and there is no reason why a start should not be made on the production of some of the chemicals required for the plastic industry.

The two most important groups of synthetic resins for the plastic industry are the phenolic and urea resins. The raw materials required for their

manufacture are phenols, urea and formaldehyde and assuming that sufficient quantities of these materials are produced in India, a foundation of the plastic industry can be well laid.

In an article of this type, it is not possible to deal with full details of the manufacture of either the chemicals or the synthetic resins ; nor can the above mentioned three sections of the plastic industry be fully described. Such notes as are given below are intended merely for the better understanding of the plastic industry as a whole.

Phenol-formaldehyde Resins

As their names imply, these resins are produced by reacting phenol with formaldehyde under carefully controlled conditions. Other phenolic bodies such as cresols are also employed, the cresol resins being of a lower grade than the phenol resins.

Phenol as already stated is a byproduct of coal distillation but, as the supply although considerable exceeds the demand, is also produced synthetically from benzene (another coal-tar product). Formaldehyde on the other hand is obtained from methyl alcohol by distillation of wood or may be synthesized from coal by way of "water gas".

When phenols and formaldehyde are mixed, a clear liquid mixture is obtained. The mixture on heating under controlled *p*H conditions reacts chemically and water is split off. After the separation of water, a viscous liquid is obtained which solidifies on cooling. The resin at this stage (called the "A" stage) is completely soluble in alcohol and can be fused and the final or the "C" stage of total insolubility and infusibility is obtained on further reaction. The resin is in "B" or the intermediate stage when the reaction has been allowed to proceed to such a degree that it has become mostly insoluble but will fuse and flow under heat and pressure.

The soluble resin in "A" stage is utilized for the following purposes :—

A. Moulding Powders.—These are produced by incorporating fillers, plasticizers, mould lubricants, dyes and pigments. Fillers used are wood flour, asbestos, mica, cotton flock, etc. and may constitute as much as 50% of the finished powder. The properties of the finished moulding depend to a great extent upon the filler, and by varying the quantity and type of filler mouldings with different properties are obtained. The most commonly used filler is the wood flour which is the cheapest and gives quite satisfactory results for many purposes.

The incorporation of fillers and other ingredients is carried out by either the wet or the dry process. The wet process consists in adding the fillers and other materials to an alcoholic solution of the resin, removing the solvent, drying, grinding and sifting. In the dry process, the solid resin is crushed, mixed with fillers etc., on hot rolls to a plastic stage ("B" stage), cooled, and ground to the required mesh.

B. Cast Phenolic Resins.—Instead of producing moulding powders, the soluble resin may be cast in simple inexpensive moulds to produce rods, tubes etc., which may be fabricated into various objects by the usual machining operation generally employed with metals, for example working on a lathe, drilling, grinding etc.

The phenolic resin used for casting is produced under somewhat different conditions. Phenol and formaldehyde are reacted together at a comparatively low temperature in a pure nickel-lined kettle to prevent discoloration. The resin is then dehydrated under vacuum and is agitated from 10-20 hours, after which colours are added. The resin is then poured into moulds which usually are made of lead. The filled moulds are then placed in an oven at about 80°C for 4-12 days, depending upon the base resin and the purpose for which it is used.

The main advantage of this process is that neither heavy hydraulic presses nor expensive moulds which are essential with moulding powders are required. Lead moulds are simply and cheaply constructed and after use are remelted and reused. Castings need not necessarily be in the form of rods, tubes etc. Life-size transparent figures have been cast by this simple technique.

C. Laminated Products.—Sheets of paper and other absorbent materials are impregnated with alcoholic solution of the resin and, after drying under carefully controlled conditions, cut into size to suit the processes available. A predetermined number of such sheets, according to the required size of the compressed board, are then piled on top of another, placed between two highly polished metal sheets and pressed in a heavy hydraulic press. The laminated board is cured at about 170°C under a pressure of 0·5-1 ton per square inch. The press may contain as many as a dozen "daylights" (platens) so that twelve laminated boards may be produced in one pressing.

Laminated materials have been used for various applications, particularly for insulation, structural and engineering work. Noiseless gears and heavy duty bearings, for example, are made from a fabric based laminated material. Laminated wood has been extensively used in the aircraft and other industries. Plywood is another instance of lamination.

Some of the important properties of mouldings of the three types are given below.

Besides these uses, the soluble phenolic

resins are also used in the paint and varnish industry but this aspect is outside the scope of the present article.

Moulding	Specific Gravity	Tensile strength Tons/Sq. inch	Compressive strength Tons/Sq. inch
Wood flour moulding powder	1·25 1·52	2—4	7—14
Cast phenolic resin ..	1·27 1·32	2·5 -5	6 13
Laminated paper base	1·3 1·4	3—7	9—18
,, fabric base	1·3 - 1·4	7 8	9—20

Urea-formaldehyde Resins

Urea is found in urines but industrially is prepared by reacting ammonia with carbon dioxide to form ammonium carbonate which on loss of water gives urea. It can also be obtained from calcium cyanamide.

Urea and formaldehyde when reacted under controlled conditions form a syrup, from which a solid, fusible, and water soluble resin is obtained. Like the phenolic resin, urea resin is used for the production of (*a*) moulding powders by mixing with fillers, and (*b*) laminated materials.

The most generally employed fillers are the wood flour and finely shredded paper. Since the urea resins and fillers are water white, mouldings with delicate pastel shades which are impossible to obtain with phenolic resins, can be produced by incorporating suitable pigments and colours. The first plastic cups and saucers were produced from urea-resins, as they are both odourless and tasteless. The use of urea resins has considerably increased since those early days and many commonly used articles are moulded from them. Examples are radio cabinets, translucent lamp shades, screw tops for bottles, buttons, cigarette-boxes etc. Urea mouldings are extensively used in the electrical industry as, unlike the phenolics, they are non-tracking.

Laminated materials are produced from urea resins by impregnation and consolidation of the impregnated paper in a manner similar to that described for the phenolics. The main use of the urea-laminated board has been for table tops and other decorative work.

Urea resin solutions have been extensively used as glues in the manufacture of plywood and for bonding various other materials together Aircraft industry has used these glues extensively, an example being its use in the fabrication of "Mosquito" fighter-bombers.

Moulding and Fabrication of Plastics

Various operations involved in the fabrication of objects from plastics can be divided into 5 groups as follows:—

(1) *Blowing or Shaping.*—These processes are carried out with only thermo-plastic materials such as celluloid and acetate sheets and need not be considered here as this article is mainly concerned with thermosetting plastics.

(2) *Machining of Plastics.*—All plastics can be machined in a similar manner as the metal. Generally the thermoplastic materials are more easy to machine than the thermosetting plastics and in the latter group, those containing no fillers are simpler to handle. As already mentioned, machining operations are only carried out when the material is produced in either sheet, block, rod or tube form, by either casting, extruding or laminating. These machining operations are a common practice in engineering practice and the usual high speed tools are employed.

(3) *Extrusion of both thermoplastic and thermosetting plastics through a nozzle or a die.*—In the case of thermosetting materials, the moulding powder is compressed and heated at a low temperature to flow point in one chamber of the extrusion machine and then forced by means of a plunger through a nozzle of simple circular or square cross-section when a rod is required. In the case of tubes, a concentric mandril is inserted, the plastic being forced through the nozzle into the annular space between the two. The die is progressively heated along its length to the curing temperature. The finished tube or rod is sawn off in convenient lengths after careful inspection for faults such as scorching etc.

(4) *Injection Moulding.*—This process is mostly used for thermoplastic materials, although in recent years, thermosetting plastics have also been moulded by this technique. In broad principle the process is very similar to extrusion technique except that whereas in the latter only tubes or rods are produced from which finished objects are obtained by machining operations, in the case of injection mouldings, finished mouldings of the required objects are obtained. The process consists in softening the plastic material in one chamber of the injection machine and forcing the softened material by means of a piston into a closed mould. In the case of thermoplastics, the mould is kept cold and the pressure is maintained by the piston until the moulding is cold. The piston is then withdrawn, the mould opened and the finished moulding ejected.

In the case of thermosetting resins, the mould is kept hot and the nozzle is continuously cooled by water. A special conversion unit with thermocouples for indicating both heater and mould temperatures is, however, necessary for adopting the standard

injection machines for moulding thermosetting plastics. Injection moulding of thermosetting materials is claimed to give a shorter time cycle and more homogeneous and dense mouldings. Using an equivalent number of mould cavities, the injection process would give 5 or 6 times the number of mouldings produced by compression process in the same time.

(5) *Compression Moulding.*—This is the most commonly employed process for the moulding of thermosetting resins of phenolic and urea type.

Heavy hydraulic or mechanical presses are employed, the platens of which are heated by either steam, gas or electricity. The mould is divided into two parts, each of which is held on the platens. The moulds may either be a single or a multi-impression one. In the latter case more than one moulding is obtained in a single pressing. A predetermined quantity of the moulding powder or a compressed tablet thereof is placed in the lower half of the heated mould. The top half of the mould is then slowly lowered, and at first a comparatively low pressure of about 300 lbs. per sq. inch is applied. At this stage the mould is not fully closed. After a few seconds the pressure is increased to a little over 1 ton per sq. inch and the mould is finally closed. Under heat and pressure, the powder softens and flows to fill every cavity of the space between the two halves of the mould. The temperature of the mould is kept at about 170°C and the pressure is maintained for ¼—1½ minutes depending upon the size and thickness of the moulding to fully harden or "cure" the material. The pressure is then released and the moulding removed by hand or ejected with special pins without cooling the mould. In most cases the moulding needs no further finishing operations except the removal of "flash" which is due to squeezing out of the excess powder between the two halves of the mould.

It need not be mentioned that a number of trial experiments are necessary to determine the quantity of the moulding powder to be used and to find the best temperatures and time of curing before any particular object can be continuously moulded.

MEDICINE AND PUBLIC HEALTH

PENICILLIN CONTROL ORDER

THE Government of India has promulgated an order for the preparation and manufacture of the anti-infective organic acid penicillin, produced by *Penicillium notatum.*

'Penicillin' (crude filtrate), is the solution obtained by the filtration of culture containing penicillin grown on or in a liquid or other medium or of extracts from such cultures.

'Penicillin' (dried crude filtrate) is substance obtained by reducing penicillin (crude filtrate) to a dry condition.

'Penicillin Salt' is the substance separated by the application of chemical and physical processes from the culture medium on or in which a mould producing penicillin has been grown and reduced to a dry condition.

Penicillin cannot be manufactured by any name other than the names mentioned above and should conform to the provisions of this order.

The standard preparation is a quantity of a dry penicillin salt kept at the National Institute for Medical Research, Hampstead, London.

Penicillin (crude filtrate) containing less than 10 units per c.c. and penicillin (dried crude filtrate) containing less than 0·75 units per milligramme shall not be issued. Preparation of penicillin intended for use in making solutions for parenteral injection shall contain less than 150 units of penicillin per milligramme.

Following a conference in London in October last year, attended by representative of Britain, the U. S. A., Canada, Australia and Free France and specialists from South Africa and India,—with the advice of Sir Alexander Flemming, the discoverer of penicillin, an international agreement on a world-wide uniform standard and unit of penicillin was reached by the Health Committee of the League of Nations. Announcing this decision, Sir Henry Dale, President of the Royal Society said that British manufacturers had made an agreement to pool all their information and to give all their results to the Medical Research Council and make the manufacture of penicillin a genuinely national effort.

The Government of India have now decided to appoint a Committee to advise the Government on

the steps to be taken to manufacture penicillin in India. This decision was arrived at a meeting of the Governing body of the Council of Scientific and Industrial Research held under the presidentship of Sir Ardeshir Dalal, Member for Planning and Development.

INDIAN MINERS' HEALTH

An account of the general conditions of health and sanitation in the coal field areas of Raniganj and Jharia is given inter alia in the Annual Report of the Chief Inspector of Mines in India for the year ending December 31, 1942. The general health of the mining population in Raniganj continued to be satisfactory and even indicated some improvement as the death rate per thousand of population fell from 19·4 in 1941 to 12·6 in 1942. The rate of infant mortality also declined from 105·5 per thousand births in 1941 to 85 in 1942, and there was also a fall in the birth-rate. Malaria, small-pox, cholera, leprosy and other diseases menaced the health of the mining population as usual in the year under review. The Asansol Mines Board of Health undertook intensive anti-malaria work in a large number of areas where malaria was rampant. The outbreak of small-pox was on a limited scale. For the prevention of cholera which broke out in August, the sanitary department adopted intensive measures for the protection of water supply, isolation and quarantine along with detailed disinfection. The campaign against leprosy was carried out by the Board in co-operation with the Asansol Leprosy Relief Association. The Association was responsible for the maintenance of 14 leprosy clinics, a leper hospital, segregation camps for infectous cases and a staff of trained health visitors. Twelve maternity and infant welfare centres, under the supervision of a medically qualified Lady Superintendent, served 47 collieries, 71 villages and 1 town ; 5 welfare centres are now provided with maternity wards for admission of cases among miners' families. A higher standard of health than that of the general population was maintained among the colliery population in Jharia, which had a death rate of 6·75 per thousand in 1942 as against 8·09 in the previous year. The corresponding figures for the general population were 12·02 and 14·37 for 1942 and 1941 respectively. There was a decline in the rate of infant mortality. Active measures including mass inoculation, phage administration and disinfection of water supplies were undertaken to control outbreak of cholera. The Jharia Mines Board of Health carried on maternity and child welfare work at 11 centres and also pursued an anti-malaria scheme by conducting surveys and giving technical advice to collieries for remedial measures.

CAUSES OF DERMATITIS

A revised edition of Health Practices Pamphlet No. 10, Skin Affections, published by the National Safety Council of the U. S. A., mentions a number of important factors causing dermatitis. Industrial workers in chemical and metallurgical works are frequently exposed to these causes and may do well to take note of them by way of personal safety.

(1) Substances such as alkali, turpentine, and soaps etc. act as detergents and keratin solvents, that is, they remove the natural oil from the skin and set up a reaction with the oils of the skin to increase susceptibility to chemicals (cotton-seed and olive oils, alcohol and phenylene bases, and several aromatic hydrocarbons).

(2) Desiccators and hygroscopic agents such as sulphur dioxide and trioxide, nitrous anhydride, phosphorus pentoxide, nitric anhydride, strong acids and alkalis take water out of the skin and generate heat.

(3) Heavy metallic salts and those which form alkaline albuminates in combining with the skin, as mercuric and ferric chloride, and alcohol, tannic acid, formaldehyde, picric acid, phenol, and strong ultra-violate rays precipitate protein and tend to coagulate the outer layers of the skin.

(4) Hydrolytic and electrolytic substances which unite with water of the skin and thus form irritating compounds or dissociate into irritating elements when in contact with water or electricity. Examples are mustard gas, nitrate of ammonia, hexamethylene tetramine.

(5) Oxidizers, such as nitrates, chlorine gas, iodine, bromine, hypochlorites, ferric chloride, hydrogen peroxide, chromic acid, permanganates, ammonia, ozone and others.

(6) Toxic nitro-derivatives which are solvents of essential skin constituents ; for example, materials of this type are T.N.T., D.N.T., tetryl, picric acid, phenols, cresols.

(7) Keratogenic and neoplastic agents which stimulate abnormal growth and may cause either malignant or benign tumours. These materials are typified by arsenic, coal-tar products, petroleum and shale, and aniline and other dyestuff intermediates.

(8) Biotic agents, vegetable and animal.

(9) Allergic or anaphylactic proteins which produce antibodies in certain sensitive persons.

(10) Photographic developers, tar, phenols and naphthols, aromatic and aliphatic hydrocarbons, salts of titanium, resorcinol, formaline, paraldehyde and salicylic, formic, and oxalic acids act as reducers. These break up water on the skin and thereby free hydrogen which thickens the outer skin layer and, in strong solutions, causes shedding of the horny layers.

ABNORMAL CHLORINE CONTENTS OF VIOFORM

A. DAS and S. L. MUKHERJEE,

RESEARCH SECTION, ALBERT DAVID LTD. (LABORATORIES),

THE paper by Pal and others on "The Quality of Indian-made Synthetic Drugs—II", in which a comparative laboratory and clinical study was recorded of 'Vioform' of Ciba and of some Indian manufacturers has certainly revealed some important facts which affect equally the manufacturers as well as the users of this drug. They recorded an abnormally high chlorine content in 'Vioform', (iodochloroxyquinoline) both Ciba's and of some Indian manufacturers, without offering any explanation of such abnormalities and perhaps they did not realise the implications of such abnormalities as to the purity of this drug in question. The virtue of this drug as an effective anti-dysenteric remedy has definitely been established by many workers in the past (Leake, David *et al*) and particularly due to the present shortage of emetine, this drug is finding an ever-increasing popularity with the medical profession of India to-day.

Considering these factors and bearing in mind some recorded cases of gastro-intestinal irritation with continued use of this drug which contains a high percentage of iodine coupled with N. N. R's views to use this drug with caution in cases with liver damage, it is felt that this drug should be offered to the medical profession in such an approved state of purity which will eliminate chances of untoward reactions on prolonged and continued use of this drug.

With this end in view the writers, while trying to explain the abnormality of chlorine content, were confronted with such facts as could not be dismissed lightly and needed clarification for general interest. It is very curious, as was pointed out by Pal and others, that while the melting point and the iodine content of samples analyzed by them were very close to the Standard, the chlorine content was found to have exceeded by about 36 per cent over the theoretical as shown in Table I.

TABLE I

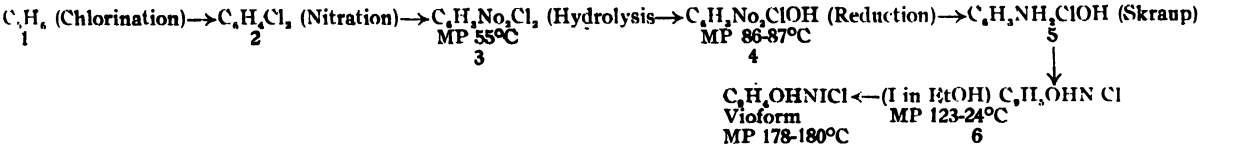
	M.P.	Iodine %	Chlorine%
Vioform			
5-Chlor-7-Iodo-8-Hydroxy-quinoline (Theoretical) ...	178-180°C	41·57	11·62
N. N. R. Standard ...	178-180°C	37·5-41·5	11·5-12·2
Indian-made Vioform			
Some Indian samples excepting No. 9 sample as analyzed by Pal and others (Average figure)	176·7°C	40·05	15·88
Vioform (Ciba) as analyzed by Pal and others ...	177·5°C	40·93	15·1

Some possible explanation of this disproportionate increase of chlorine values can be gathered from the following review of the different methods of synthesis of Vioform at present commonly utilized for its manufacture.

Flow sheets of different methods of Vioform synthesis indicating possible sources whereby chlorine content of final product may be higher are given below.

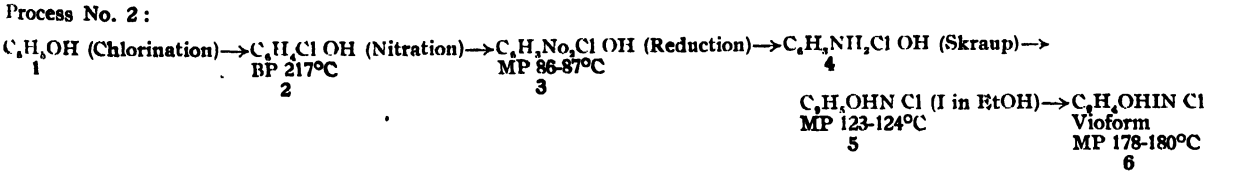
In Process No. 1, incomplete hydrolysis at stage 3 may give rise to the presence of dichloroquinoline in the final product to influence higher chlorine value.

Process No. 1:



In Process No. 2, chlorination of phenol at the 1st stage may give rise to a mixture of C_6H_4 ClOH (BP 217°C) and $C_6H_3Cl_2$ OH (BP 210°C) and if careful fractionation are not effected as their boiling points are very close, dichlorophenol is likely to remain in some proportion in the 2nd stage which on subse-

Process No. 2:



quent stages of nitration, reduction, and Skraup reaction, may eventually show off as dichloro-hydroxyquinoline MP 178-179°C influencing higher chlorine value of the final product.

either dichloroquinoline or diochlorohydroxyquinoline. Further since phenol is available in India at a reasonable cost, process No. 2 which eliminates one stage (hydrolysis) in the synthesis should gain favour

Process No. 3 :

C_6H_5OH (Nitration) → $C_6H_4No_2OH$ MP 44-45°C (Reduction) → $C_6H_4NH_2OH$ MP 173-174°C (Skraup) → C_9H_6OHN MP 73°C (ICl_3) → $C_9H_4OHIN\,Cl$ Vioform MP 178-180°C

1 2 3 4

In Process No. 3, at the last stage (4) of synthesis, where 8-hydroxyquinoline had been subjected to the action of ICl_3, the mechanism of reaction not being exactly known, the formation of Vioform may be explained in the following way :—

(a) ICl_3 at the first stage chlorinates and breaks down to ICl.

(b) ICl subsequently effects iodination.

So in this process also, there is always a chance of chlorination proceeding a stage further than desired and thus presence of dichlorohydroxyquinoline in the final product is not unlikely to account for higher chlorine value. Besides, on subsequent action of ICl, there may always remain a part of monochloro derivative unreacted. More curious is the fact, which is rather somewhat difficult to explain, that the action of ICl_3 on 8-hydroxyquinoline in a variety of media results in the invariable formation of appreciable amounts of di-iodohydroxyquinoline which in turn may give rise to higher iodine value of the final product.

In the following table the possibilities of presence of different compounds in respective mode of synthesis with their iodine and chlorine percentages are shown.

TABLE II

Modes of synthesis followed	Possible presence of diff. comp.	Iodine %	Chlorine %
Process No. 1	(a) C_9H_4OH 1NCl Vioform	41·57	11·62
	(b) Unreacted C_9H_5OHNCl	...	19·77
	(c) $C_9H_5NCl_2$	...	35·85
Process No. 2	(a) $C_9H_4OHINCl$	47·57	11·62
	(b) Unreacted C_9H_5OHNCl	...	19·77
	(c) $C_9H_4OHNCl_2$	...	33·17
Process No. 3 ...	(a) $C_9H_4OHINCl$	47·57	11·62
	(b) $C_9H_4OHNI_2$	63·97	...
	(c) $C_9H_4OHNCl_2$	...	33·17
	(d) C_9H_5OHNCl	...	19·77

Reviewing the first two processes of Vioform manufacture, it is apparent that if proper purity control at different stages is not maintained, the final product obtained may possibly be a mixture of Vioform, unreacted 5-chlorohydroxyquinoline and with Indian manufacturers. Starting with phenol, the first step towards Vioform synthesis is chlorination of phenol where a mixture of 4-chloro-phenol (BP 217°C) and 2 : 4 dichlorophenol (BP 210°C) is likely to be formed and since their boiling points are rather closer, if proper fractionation is not effected, 2 : 4 dichlorophenol would naturally influence the final product.

If we assume that this chance has been eliminated and at the penultimate stage of synthesis, 5-chloro-8-hydroxyquinoline is obtained in a good state of purity it becomes extremely difficult to account for such high chlorine content in the final product only on the assumption that imperfect iodination has been effected at the final stage. The following table will offer a guide.

TABLE III

% of Vioform MP 178-180°C	% of unreacted monochloro Comp. MP 123-124°C	% of Iodine in the final mixt.	% of Chlorine in final mixt.
95	5	39·49	12·02
90	10	37·41	12·43
80	20	33·25	13·25
75	25	31·17	13·65
70	30	29·09	14·06

It is apparent from the above figures that imperfect iodination cannot alone account for such high chlorine figure (15·88) in the sample of Vioform analyzed by Pal and others with such high iodine content and close melting point corresponding to the theoretical Vioform. Hence it can be assumed that the product at the penultimate stage of synthesis is not a pure product but a mixture of monochloro and dichlorohydroxyquinoline which on subsequent iodination is converted into a mixture of Vioform, unreacted monochlorohydroxyquinoline and unchanged dichlorohydroxyquinoline.

From these figures possible explanations for increased chlorine content as well as close agreement to the observed melting point can be offered but increased iodine content as observed remains still to be explained. It is seen that with the increase in chlorine content, iodine figure should proportionately decrease but workers acquainted with iodinations of 5-chloro-8-hydroxyquinoline with iodine in EtOH, should agree

with the writers' personal experiences on this point, that at this stage certain amount of iodine is found

TABLE IV

% of Vioform MP 178-180°C	% of Mono-chloro MP 123-124°C	% of Dichloro MP 178-179°C	Final % of Iodine	Final % of Chlorine
80	10	10	33·25	14·59
85	5	10	35·33	14·18
80	5	15	33·25	15·25
Assuming monochloro Compound to have been eliminated				
95%	...	5	39·49	12·69
90%	...	10	37·41	13·77
85%	...	15	35·33	14·85
80%	...	20	33·25	15·93

to have been always adsorbed by the final product, and freeing the final product from adsorbed iodine entails thorough suitable washing and repeated crystallization. Retention of this adsorbed iodine by the final product may perhaps be the reason why samples of Vioform examined by Pal and others gave a disproportionate increase of iodine value along with higher chlorine values, in close agreement to the melting point.

So if No. 2 process of synthesis has been followed by manufacturers, it is possible that samples of Vioform examined by Pal and others are likely to have contained a mixture of about 80 per cent Vioform, 15 per cent monochloro and dichlorohydroxyquinoline with about 5 per cent adsorbed iodine.

If process No. 3 has been followed for Vioform manufacture and if proper purification of the final product has not been effected, it is very likely that the final composition would contain a mixture of Vioform, 5:7 di-iodo-hydroxyquinoline, dichlorohydroxyquinoline and partly monochloro compound. In the following table different proportions of the

TABLE V

% of Vioform MP 178-180°C	% of 5:7 Diiodo Comp. MP 185-187°C	% of Dichloro MP 178-179°C	Final % of Iodine	Final % of Chlorine
95	5	...	42·68	11·03
90	5	5	40·60	12·11
80	10	10	39·65	12·61
75	10	15	37·57	13·69
70	15	15	38·69	13·10
60	20	20	37·73	13·62
80	5	15	36·45	14·27
70	10	20	35·49	14·76
55	25	30	38·85	16·34
55	30	25	42·05	14·68

possible mixed compositions are shown to explain such increased chlorine content.

If Process No. 3 has been followed, it will be evident from the foregoing table IV that high percentage of both iodine and chlorine in the samples of Vioform examined by Pal and others can only be accounted for on the assumption of the presence of high percentage of both di-iodo-and dichlorohydroxyquinoline or else if chloro compound alone be present to cause increased chlorine perceptage then high iodine values observed can only be explained on the grounds of assuming iodine adsorption.

Since both these factors seriously affect the quality of the drug in question and may have adverse effect on its continued use, the writers felt it worthwhile to conduct an independent analysis and fractionation of a few available brands of Vioform tablets. Besides, the writers also synthesized, on a semi-commercial scale, a few samples of Vioform following different processes so as to acquaint themselves with the difficulties that are likely to arise from the manufacturer's point of view.

(1) Results of Fractionation and Analysis of a foreign brand tablet, (Chart No. 1, p. 554).

Adding all the fractions together, the total weight of solid recovered by HAC Extn. of tablets was found to be 1·28 gm.

Results of analysis of different fractions of this brand:—

Name of fraction	Iodine %	Chlorine
A	37·4	11·08
B	31·9	12·00
C	39·18	12·07
Average:	36·16	11·71

From the above results it will be seen that with this particular lot of foreign brand tablets, the chlorine values of different fractions were always within the limits of Vioform and as regards iodine, excepting fraction B, the other two were within limits, suggesting thereby that on the average, the compounds used for these tablets were practically within the N.N.R. limits of Vioform. With this brand of tablets another striking feature was that no crystalline fraction was obtained having melting points below 177-178°C and on fractionation and re-crystallization, a crystalline solid was obtained which gave a MP 182°C (fraction C) thereby casting doubt of admixtures of 5:7 di-iodo-hydroxyquinoline (MP 185-187°C). This was also ruled out by analyzing the fraction which gave comparatively better results to theoretical Vioform.

Further, it was not possible to trace presence of free adsorbed iodine in tablets of this particular lot.

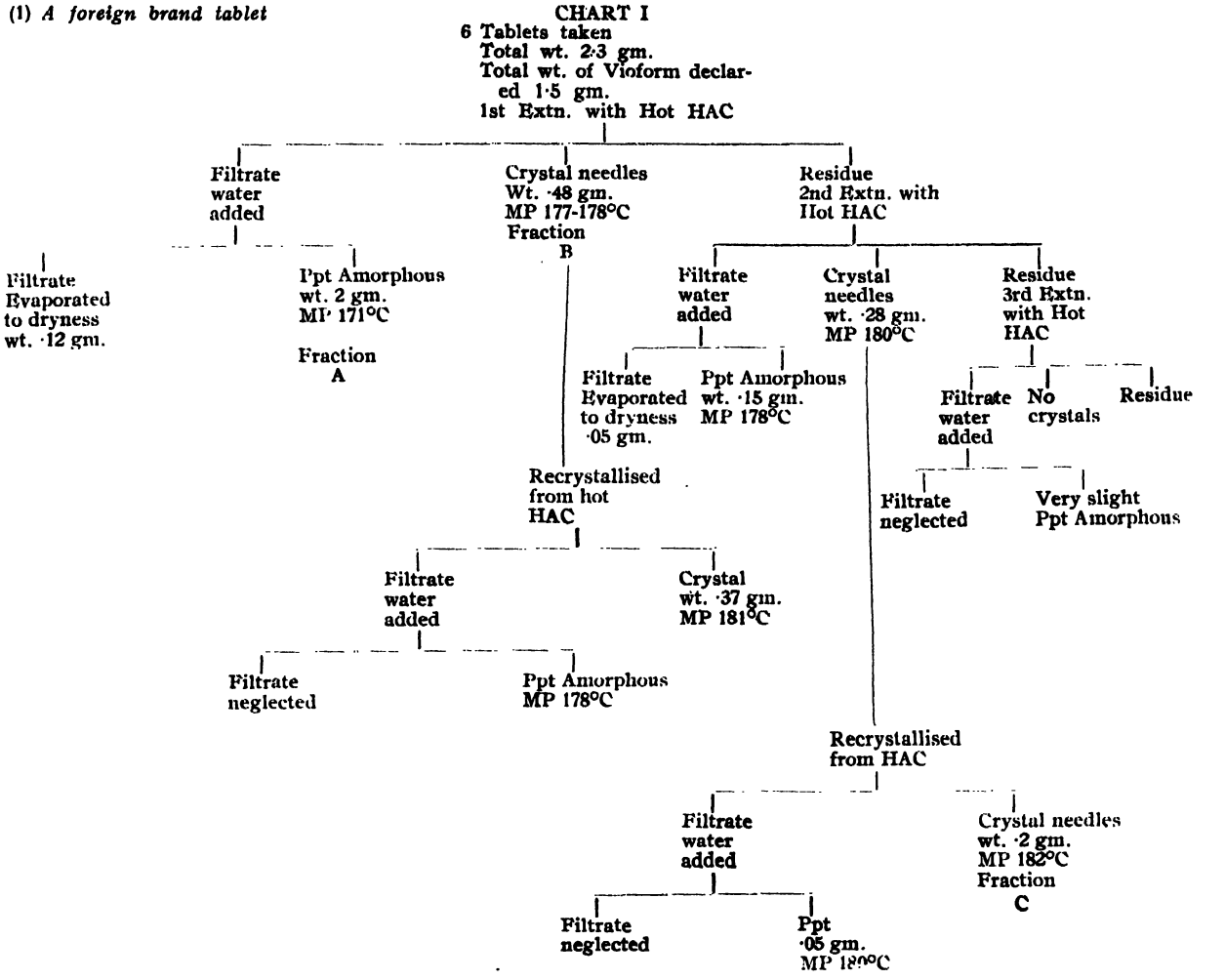
(2) Results of Fractionation and Analysis of a local brand tablet, (Chart No. 2, p. 555).

Adding all the fractions together, the total weight of solid recovered by HAC Extn. amounts to 1·13 gm.

It is to be noted in this connection that both here as well as in previous experiment, some salt in crystalline form was recovered from the filter papers used during filtration.

(1) *A foreign brand tablet*

CHART I



Results of analysis of different fractions:

Name of fraction	Iodine %	(Chart No. II) Chlorine %
A	29·25	14·84
B	38·21	13·04
C	31·32	15·01
Average :	32·92	14·29

From the results of analysis of this particular brand of tablets, it would be seen that chlorine values of all the fractions analyzed were very much above the limits of Vioform and compared favourably with the results obtained by Pal and others. With the increase of chlorine value, iodine value on the average was found to be much lower than the theoretical, a fact which stands in contrast with the results recorded by Pal and others and explains the presence of varying proportions of chloro compounds in this brand of tablets. Besides, melting points of different fractions were found always to be lower than the corresponding fractions of foreign brand of tablets.

It had not been possible to trace presence of free adsorbed iodine in tablets of this particular brand.

(3) Another local brand :

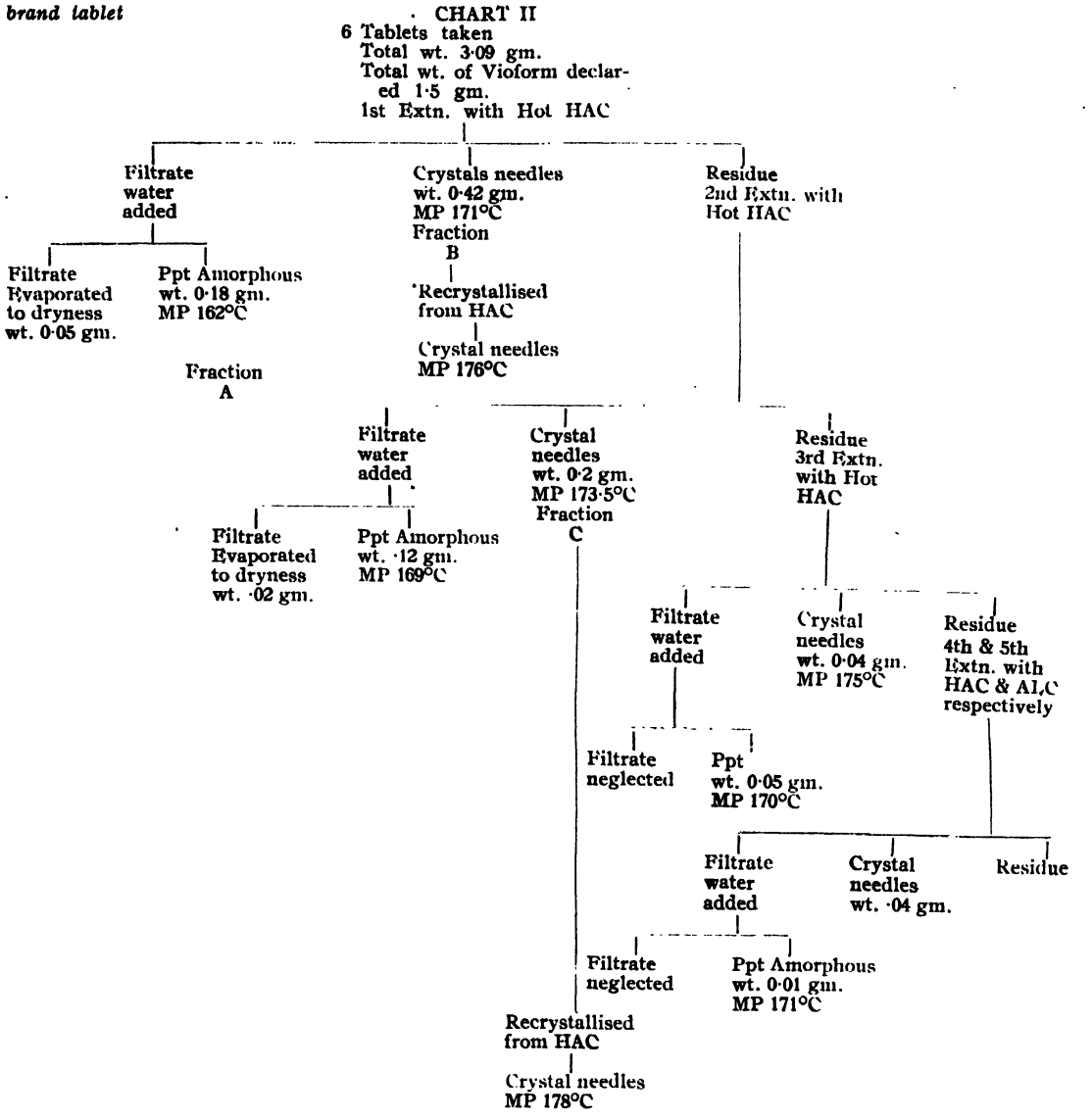
Peculiarities were noticed in this brand of tablets from which it was not possible to crystallize iodochloroxyquinoline readily either by HAC or alcohol. But some dark coloured semi-crystalline solid separated on keeping the extracts for over a week or so, a phenomenon which is most unusual with pure Vioform. Hence no fractionation of this brand was possible but an analysis on this brand of tablets was made. 3 tablets weighing 1·210 gm. were crushed finely and an average weight of a single tablet 0·4034 gm. were utilized for analysis.

Results of Analysis :—	Iodine%	Chlorine%
	26·3	11·2

From the difficulties experienced in crystallizing as well as from the disproportionate values of iodine and chlorine recorded on analysis, this brand of tablet falls far short of Vioform requirements.

(2) *A local brand tablet*

CHART II



(4) Crystalline sample obtained through the courtesy of a local manufacturer:

Sample received, light brown in colour, MP 180°C, was repeatedly recrystallised from hot HAC and a fraction obtained MP. 182°C crystallizing in needles, was finally analyzed.	Results of Analysis	
	Iodine %	Chlorine %
	40·9	12·40

(5) Crystalline sample of Vioform synthesized in A.D. Laboratories by the writers.

Results of analysis	MP	Iodine %	Chlorine%
As performed by Bio. Chem. Std. Lab.	178°C	41·5	11·08
As performed by A. D. Lab.	179-80°C	41·02	- 11·45

It is obvious from the preceeding results that no consistent analytical values were obtained from the different brands of Vioform analyzed by us and Pal and others. Only one sample out of a dozen or so was found to be within N.N.R. limits. In most cases chlorine values were very high indicating presence of high percentages of undesired chloro compounds. Considering the importance of this drug it is felt by the writers that a proper standard should be fixed for Vioform and only those that come within the standard should be marketted and used in India.

Comments on N. N. R. Standard and Suggestion for its Modification

N.N.R. limits of iodine and chlorine had been fixed on the manufacture of Vioform based on iodina-

tion of pure 5-chloro 8-hydroxyquinoline as indicated in process No. 1 and 2, the then known and available mode of synthesis. In fixing limits, special attention had been given on the purity of 5-chloro-8-hydroxy compound and in subsequent iodination it had been assumed that 90 per cent conversion of 5-chloro compound into 5-chloro-7-iodo derivative would give the basis of an acceptable standard. So it would appear from the following calculations that N.N.R. limits had been fixed working approximately on the above basis.

	Iodine %	Chlorine
(1) 90% Vioform 10% Monochloro	37·41	12·43
(2) 100% Vioform Theoretical	41·57	11·6

By repeated recrystallization from HAC, of the mixture (1), pure Vioform can be separated eliminating the monochloro derivative entirely.

It is of special interest to note that in N.N.R. limits no attention had been paid to the possibilities of an increased iodine content and a decreased chlorine content over the theoretical which lend further support to the views expressed that N.N.R. limits had been fixed on the information then available about its synthesis from 5-chloro-8-hydroxyquinoline, which not only entirely precludes chances of increased iodine percentage but on the contrary points out that should complete iodination be not affected, iodine value will be lower and consequently chlorine values slightly higher than the theoretical. Since the efficacy or otherwise of a product depends on its purity, allowing of 10 per cent impurities on a synthetic product which can be made to state of chemical purity, should naturally be considered to be very generous and may have some justification considering that Vioform is an oral preparation. Besides, lower iodine value and consequent increase of chlorine value had been suggested, bearing in mind the fact that Vioform contains a high percentage of iodine and is thereby attended with risks of iodism. But since there is a possibility of synthesizing Vioform by process No. 3, where there is a chance of 5:7 di-iodo compound being formed in addition, there is every likelihood of the product manufactured by this process to show a slightly higher iodine content and a consequent and proportionate decrease of chlorine content over the theoretical. Considering the importance and increased use of this drug in India for the control of amoebiasis, it is felt that a proper standard should be fixed for the drug in India, after due consideration of the various processes now known of Vioform manufacture, and bearing in mind as well, the necessary economy of its commercial production, as a manufacturer, our suggestion to this end is that it would be fair, just and safe should the limits be fixed as follows:—

MP 178—181°C, Iodine % 38—42, Chlorine % 11—12.

Summary and Conclusion

With pure samples of Vioform, following N. N. R's method of analysis of chlorine and iodine—results corresponding to the theoretical values are obtained.

Pal and others obtained about 36 per cent higher chlorine values in all samples of Vioform analyzed, iodine values remaining within theoretical limits of Vioform.

Possibilities of increased chlorine content are indicated and explained by referring to different processes of synthesis.

Samples of Vioform giving about 15 per cent chlorine values are likely to contain such high percentages of mixture of monochloro-and dichloro-hydroxyquinoline that serious consideration should be paid before accepting these for general use.

There was found no consistency in iodine and chlorine values of the different samples of Vioform analyzed by us and Pal and others suggesting that no hard and fast standards are followed during their preparation.

Our results differed from Pal and others in this respect that where higher chlorine values were recorded, there was always proportionate decrease of iodine values.

During fractionation of tablets, a fraction having a MP of 182°C was obtained which gave on analysis iodine and chlorine values correspondingly closer to Vioform.

Fixing a proper standard based on different methods of synthesis is urged for Vioform to be marketted in India.

References

1. Pal, J. C., Mukherji, B., Gupta, J. C. and Chatterjee, M. L., *Ind. Med. Gaz.*, *79*, 469, 1944.
2. Leake, C. D., *J. Amer. Med. Ass.*, *98*, 195, 1932.
3. David, N. A. and others, *Ibid.*, *100*, 1658, 1933.

BOOK REVIEWS

"Diagnostic Methods in Veterinary Medicine".—By G. F. Boddie. Published by Oliver & Boyd, Edinburgh, Chaps. XIX and 316 pages. Price 15 shillings net.

This book is a further addition to the series of manuals which have emanated from the Edinburgh Veterinary School since the days of the late distinguished Principal, Dr O'Charnock Bradley. The present author is now Professor of Medicine in this College.

First, there is an account of how to make a general clinical examination of the animal, followed in successive chapters by more special accounts of the examination of organ systems. The rest deals with allergic reactions, collection of material, urine analysis, methods of bacteriology and helminthology as applied in clinical practice, clinical haematology (Chapter by H. H. Holman), and post-mortem technique. It is pointed out that with animals there are special difficulties because they cannot speak and also because through fear or pain they may actually obstruct the examination. Many of the illustrations are line drawings showing regional anatomy of the domesticated animals. As the author properly points out, the basis of diagnosis must be a sound knowledge of anatomy, physiology and pathology, assisted by a close acquaintance with the appearance and behaviour of the animal in health. Some of this knowledge can only be acquired by actually working with animals, *e.g.*, by living and working on a farm. The progress of preventive medicine in turn rests on an accurate diagnosis. In diagnosis, clinical examination forms the basis, while various laboratory methods are of the nature of aids to diagnosis. The final assistance may be derived from a post-mortem examination of one or more individuals of the herd.

The reviewer has formed a good opinion of this book, which is intended for students, teachers and practitioners. The information is clearly expressed and is amplified by very numerous examples. A person who reads and studies this book and is fortified by practical experience cannot fail to become a good veterinary practitioner. The only possible criticism is that rather too much is made of clinical niceties and rather too little emphasis laid on laboratory procedures which may be decisive in diagnosis.

The publishing work is of the high quality one is accustomed to expect from Oliver & Boyd, particularly as this is a wartime book.

F. C. M.

Manufacture of Lead and Slate Pencils.—By N. N. Godbole, Principal, College of Technology, Benares Hindu University. Price Rs. 4/-.

The booklet gives a general idea of the raw-materials graphite, clay, wood for the manufacture of lead and slate pencils as also the methods of these manufacture ; although it cannot claim to be helpful from the point of view of technology, it is certainly valuable for general industrial education and for cottage industries. All the articles were written near about 1917 and although the industries dealt with have much advanced in India and as such have not been reflected in their present advanced condition in the booklet, they give a historical background of much readable information. *M. G.*

Post-War Reconstruction—A General Survey—By Prof. Maneck B. Pithawalla, Karachi.

Prof. Pithawalla has come out with a general discourse on principles of Planning for Post-War World. The readers have been presented with a number of technical plans by eminent authors. This one is a happy digression in that it advocates a change of heart before a change in economic structure is contemplated. We agree with Prof. Pithawalla that there has been no proper study and understanding of man and his aspirations in the different parts of the world. To-day everywhere there is much of distrust and jealousy, rivalry and hatred among mankind. The author has given his own suggestion for a new approach. These could have been made more comprehensive. *K. B.*

Geography and the World War.—By Prof. Maneck B. Pithawalla, Karachi, 1945. Price Rs. 1/8/-.

In a short compass of seventeen pages Prof. Pithawalla has attempted to show the influence of geography behind current history and tried to indicate the lines on which post-war developments are to be tackled so that wars may be avoided in future. The present war more than any other wars has focussed the attention of people to the importance of a geographic basis of viewing things. Prof. Pithawalla's pamphlet will stimulate thoughts in this direction. Geographical causes of the war, the way in which strategy is dependent on physical features, to what extent people can overcome the effects of abrupt changes of climate etc. are some of the aspects stressed in this articles. One may not fully agree with the views sponsored by the author in course of his discussion, but will surely appreciate the discourse.

K. B.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ON A METHOD OF CONSTRUCTING A CYCLIC SUBGROUP OF ORDER p+1 OF THE GROUP OF LINEAR FRACTIONAL TRANSFORMATION MOD p

If p is a prime, it is well-known that the linear fractional transformations $x^* = (ax + b)/(cx + d)$, (mod p) form a triply transitive group of degree $p+1$ and order $p(p^2-1)$, which contains a cyclic subgroup of degree and order $p-1$ (Cf. Carmichael, Groups of Finite Order p. 266). We here give a method of constructing a cyclic subgroup of degree and order $p+1$. If $x^2 = a_1x + a_2$ is the equation satisfied by any primitive element of GF(p^2), a, and b belonging to GF(p), then the desired subgroup is generated by the transformation $x^* = a_2/(a_1 + x)$.

The result can be easily generalised to the group of order $p^n(p^{2n}-1)$ which we get if a, b, c, d are marks of GF(p^n).

R. C. Bose
S. Chowla

Calcutta, 31-8-1944.

PHOSPHORYLASES FROM POTATO TUBERS

The phosphorylase isolated from local potato by following Hanes' method[1] was found to be always associated with a strong phosphatase (glycerophosphates as substrates). This latter enzyme could be removed by adsorption on kaolin and also on Alumina Cγ. Adsorption on Alumina Cγ proved to be of special interest since it showed the possibility of occurrence of two different phosphorylating enzymes (we call them phosphorylase A and phosphorylase B respectively). Phosphorylase A is adsorbed by Alumina Cγ whereas the other is not.

For the separation and purification of these two enzymes, the following procedure, which differs in some respects from that of Hanes, was finally adopted.

Separation of the enzymes.—The crude potato juice was frozen without delay at a low temperature. The frozen mass was thoroughly crushed and the enzyme was eluted out with cold dilute ammonium sulphate solution. (As far as practicable all operations are conducted at or below 0°C and with toluene or chloroform as preservative). The mixture was centrifuged ; the supernatant is found to contain a slimy substance which prevents the settling of the crude enzyme precipitate when the ammonium sulphate concentration was sufficiently increased. $BaSo_4$ precipitated inside the liquid mass by addition of a few drops of $BaCl_2$ solution was helpful in removing this interfering substance. After centrifuging off the $BaSO_4$ precipitate, the enzyme was precipitated by addition of saturated ammonium sulphate and centrifuged hard or filtered. The crude precipitate was then suspended in ice-cold water and precipitated at 0·5 saturation of ammonium sulphate (phosphorylase A). To the filtrate was added more ammonium sulphate and left overnight in the refrigerator. A small precipitate formed and was filtered. This was also found to contain phosphorylase activity and is the phosphorylase B.

Purification.—This enzyme B was further purified by a repetition of ammonium sulphate fractionation and then was taken up in a small amount of water and allowed to be adsorbed on Alumina Cγ. In order to avoid unnecessary dilution of the enzyme, the adsorbent (5-10 c.c.) was previously centrifuged, the enzyme solution being then added to the residue and thoroughly mixed. The process was repeated with fresh portions of the adsorbent. It was found that the first 1 or 2 treatments showed that the adsorbate contained a small phosphorylase activity - presumably due to traces of the enzyme A. But the later treatments gave adsorbates with no activity, while the supernatant (*i.e.*, the portions unadsorbed) showed considerable activity. It may be mentioned that for these studies the adsorbate itself could be used as a source of enzyme without previous elution.

Purification of enzyme A.—The crude enzyme A precipitated at 0·5 saturation of ammonium sulphate was fractionated repeatedly by ca 0·3 saturation of ammonium sulphate and reprecipitation at 0·4 saturation. In one instance it was found possible in this way to get a sample of enzyme which was completely adsorbed on Alumina Cγ leaving no enzyme portion in the supernatant.

Thus potato phosphorylase appears to be a mixture of at least two phosphorylating enzymes: (*i*) Enzyme A, precipitated below 0·5 saturation of ammonium sulphate and is characterised by complete adsorption on Alumina Cγ (*ii*) Enzyme B, precipitable only at a higher concentration of ammonium sulphate and is not adsorbable by Alumina Cγ Whether our enzyme B is identical with the recently discovered 'Q' Factor of Haworth[2] is yet to be determined. In this connection the previous ultracentri-

fugal study of potato-phosphorylase by Green and Stumpf[3] is also of interest.

A. K. RAI CHAUDHURY.

Bio-Chemical Laboratory,
Bose Research Institute,
Calcutta, 23-3-1945.

[1] Hanes, *Proc. Roy. Soc.*, Lond. Series B, *129*, 192, 1940
[2] Haworth, Peat & Bourne, *Nature*, *154*, 236, 1944.
[3] Green & Stumpf, *J. Biol. Chem.*, *142*, 355, 1942.

OPTICAL CONSTANTS OF CADMIUM AND MOLYBDENUM STUDIED BY POLARIMETRIC METHOD

The gradually increasing application of quantum mechanics to the metallic state has created a new interest in the experimental investigation of optical constants of metals. For some time past we[1,2] are engaged in determining the optical constants for the metals which have not been thoroughly worked as yet and studying the effect of polish and contamination of their surfaces. This note contains the experimental data for cadmium and molybdenum with a short discussion of the effect of polishing.

The experimental arrangement is similar to that of Drude.[3] A plane-polarised light at an azimuth of 45° was allowed to fall on the metallic surface and the state of polarisation of the reflected light was investigated with a Fuess polarisation spectrometer modified to suit our purpose ; an ellipticity-half-shade, as suggested by L. Tronstad,[4] and an azimuth-half-shade were locally constructed and mounted for increasing the sensitiveness of the apparatus. The two most important optical constants with which we are concerned are n, the refractive index and k, the co-efficient of absorption according to Drude's notations (Mott uses K for nk and calls it the extinction co-efficient).

The literature of the subject shows that the data for cadmium[5] and molybdenum[6] are meagre. We have determined these for the range 4400 A° to 6600 A° at intervals of 200 A°. White light from a point-o-lite lamp was passed through a monochromator from which a narrow band of spectrum of desired mean wavelength was chosen. The surface of the metal plate was rubbed with coarse emery paper in a particular direction, and at right angles to this with the next fine emery paper. The process was continued till the finest emery paper was employed ; fine scratches were then removed by gently rubbing the surface alternately with finely powdered aluminium oxide and with magnesium oxide on a pad of old cloth ; this method of slow hand polishing was continued till scratches were removed ; the surface was then washed with soap solution and finally with alcohol to remove traces of grease. First set of observations (A) was made on lightly polished metallic surfaces ; the same surface was further polished and a second set of observations (B) was made. Representative values are given in Tables I and II.

TABLE I : CADMIUM

Wave-length	nk (A)	nk (B)	n^2k (A)	n^2k (B)
6600 A°	2·78	4·38	5·16	6·30
6200	2·69	4·24	4·39	4·71
5800	2·65	3·96	3·74	3·82
5400	2·48	3·77	3·21	3·29
5000	2·29	3·47	2·63	2·67
4600	2·16	3·14	2·04	2·14
4400	2·11	3·01	2·03	2·20

TABLE II : MOLYBDENUM

Wave-length	nk (A)	nk (B)	n^2k (A)	n^2k (B)
6600 A°	3·88	4·40	11·4	13·4
6200	3·87	4·44	11·0	13·1
5800	3·88	4·36	10·6	12·5
5400	3·81	4·31	10·5	12·5
5000	3·82	4·15	9·54	10·8
4600	3·63	3·89	8·35	9·6
4400	3·46	3·83	8·29	10·0

For both the metals the values of nk and n^2k have increased with heavier polish for all wavelengths. It may be noted that cadmium is a softer metal while molybdenum is a harder one, still the quantities have undergone similar variation with heavier polish. The effect of polishing on the quantity n^2k is exactly similar to the previous observations by Mott[7] and by us that heavier polishing produces thicker amorphous layer and consequently greater absorption indicated by the increased values of n^2k. In the case of cadmium, nk has been found to be more sensitive to the method of polishing than n^2k because nk has suffered a greater change in the values after a heavier polish.

The graph of $\frac{n^2k}{\lambda}$ (which is a measure of electrical conductivity) plotted against the wavelength λ reveals that, for both the sets of observations with molybdenum, $\frac{n^2k}{\lambda}$ is a maximum at 5400 A° indicating that this metal has an absorption band in this part of the visible region.

We are thankful to the Patna University for the grant of a research scholarship to one of us (K.N.P.).

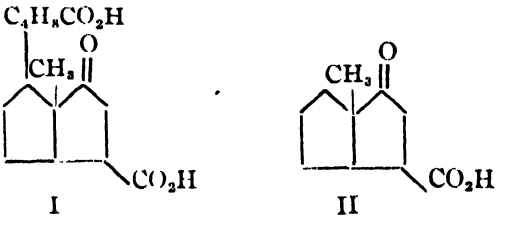
L. M. CHATTERJEE
K. N. PRASAD

Physics Laboratory,
Science College,
Patna, 23-4-1945.

[1] L. M. Chatterjee and K. N. Prasad, *Bull. Patna Sc. Coll. Phil. Soc.*, *14*, 125, 1944.
[2] L. M. Chatterjee and K. N. Prasad, *Curr. Sci.*, *13*, 177, 1944.
[3] Wood, Physical Optics, 3rd Ed., 542, 1934.
[4] L. Tronstad, *Jour. Sci. Instr.*, *11*, 144, 1934.
[5] International Critical Tables, *5*, 248, 1929.
[6] R. D. Summers, *Jour. Opt. Soc. Amer.*, *24*, 261, 1934.
[7] Mott, N. F. and Jones, H., The Theory of the Properties of Metals and Alloys, 117, 1936.

SYNTHESIS OF 7-METHYL-O-3:3-BICYCLOOCTANE-1-ONE-3-CARBOXYLIC ACID

As a preliminary to the synthesis of the pyro-keto-acid $C_{15}H_{22}O_5$ (I), obtained through the oxidative degradation of desoxycholic acid by Wieland and Schlicting,[1] 7-methyl-o-3 : 3-bicyclooctane-1-one-3-carboxylic acid (II) has been prepared by the following method.



I II

Potassiosalt of ethyl 2-methyl-2-carbethoxycyclopentyl-cyanoacetate[2] was condensed with ethyl-bromoacetate in an alcoholic solution, when diethyl α cyano - α-(2-methyl-2-carbethoxycyclopentyl)-succinate (b.p. 207°/8mm.) was obtained in good yield. 2-Methyl-2-carboxycyclopentyl-succinic acid (m.p. 208-211° with previous shrinking at 200°), which was obtained by hydrolysis of the above cyanoester with concentrated hydrochloric acid, was esterified with alcohol and sulphuric acid and the triethyl ester (b.p. 170°/5 mm.) thus obtained was cyclised by means of sodium dust in dry benzene solution to yield diethyl 7-methyl-o : 3 : 3-bycyclooctane-1-one-2 : 3-dicarboxylate (b.p. 168°/7 mm.). The above β-ketonic ester was hydrolysed by refluxing with an excess of 20 per cent sulphuric acid, when 7-methyl-o : 3 : 3-bicyclooctane-1-one-3-carboxylic acid was obtained as a viscous oil boiling at 162-165°/5mm. (semicarbazone m.p. 234°). The keto-acid on oxidation with concentrated nitric acid yielded a solid acid, which after several crystallisation from acidulated water melted at 124-126°. Mixed melting point with an authentic sample of cis-1-methyl-cyclopentane-1 : 2-dicarboxylic acid showed no depression (melting point of the above (cis-acid was found to depend considerably on the rate of heating).[3]

Our thanks are due to Prof. P. C. Mitter for his kind interest. Authors are indebted to Dr P. C. Dutta for the supply of the authentic specimen of *cis*-1-methylcyclopentane-1 : 2-dicarboxylic acid and also to Mr N. Ghosh M.Sc. for carrying out micro-analysis.

P. BAGCHI
D. K. BANERJEE

Sir P. C. Rây Research Fellow's Laboratory,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 30-4-1945.

[1] Wieland and Schlicting, *Z. physiol. Chem.*, *134*, 276, 1924.
[2] Banerjee, SCIENCE AND CULTURE, *9*, 456, 1944; *Cf.* Linstead and Errington, *J. C. S.*, 666, 1938.
[3] Dutta, *J. Ind. Chem. Soc.* *17*, 611, 1940; *Cf.* Bachmann *et al.*, *J. Am. Chem. Soc.*, *63*, 1261, 1941.

WORKING OF DIFFUSION PUMP WITH DIFFERENT OILS

FROM our study of the internal action of a diffusion pump it was convincing that the ultimate vacuum attainable by a diffusion pump would not vitally depend upon the vapour pressure of the pump fluids as it usually supposed to do. Different oils were therefore used to further corroborate our picture of the internal working of the diffusion pump. All of them gave the same ultimate vacuum according to our expectation.

Five kinds of fillings were used, *viz.*, Apiezon B, Capella oil D (Caltex Co), Mobile B, Petroleum jelley (white), and solid Paraffin. All of them gave the same vacuum of 2×10^{-5} mm. Hg. as measured on a McLeod gauge.

It is important to note that heat-input plays a vital role in the functioning of a diffusion pump, and the optimum value of the input changes considerably with different types of fillings. The (solid) paraffin diffusion pump seems to require 2-3 times heat input compared with that required for the usual oil fillings. The estimate is however tentative, as the wattage could not be measured for the gas burners used.

It is further interesting to note that the petroleum jelley and the solid paraffin gave the same ultimate vacuum but only under careful control of the heat input and the water circulation in the jacket. The flow of water was to be reduced to such an extent that the outflow was just more than dripping,

and the whole pump, including the top cover, was quite hot to the touch.

It should be noted carefully that the "pressure" recorded above refers to the air pressure alone and does not take into account the partial pressure of the fluid vapours. The measurements of the vapour pressures in the vessel, during the run of the pump, are under investigation.

Details will be published elsewhere.

Our thanks are due to Prof. M. N. Saha, D.Sc., F.R.S. for his kind interest in the work.

KAMALESH RAY
NANDA DULAL SENGUPTA

Palit Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta, 1-5-1945.

POWER REQUIRED TO OPERATE THE PNEUMATIC TIDAL MACHINE

IT was noted[1, 2] that the air pressure required in the tidal chamber Fig. 1A, for simulation of the tide in the open section (B) would not practically exceed 1 to 2 lbs. per sq. inch of gauge pressure. But the volume of the air handled is usually large depending upon the size and scale of the model. It is therefore necessary to calculate out the range of power which is required of the compressor outfit for a given model, before an installation is undertaken.

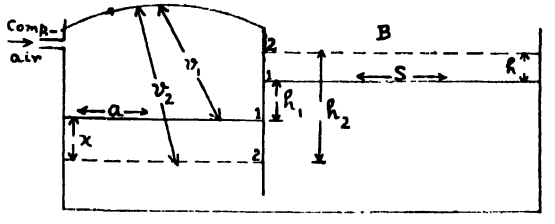


FIG. 1. Schematic diagram of the pneumatic tidal device.

The work done in operating the tidal cycles involves two parts, *viz.*, work on the water system to create more difference in water levels in sections A and B, and secondly on the gas system in the tidal chamber A where the gas (air) is raised from the initial pressure of p_1 and volume v_1 to the final conditions of p_2 and v_2 by the feed of air from the compressor.

From the consideration of the Fig. 1, it will be apparent that the change of potential energy due to the change of water levels from positions 1, 1 to 2,2 in the two sections would be given by

$$W = \tfrac{1}{2}\,\rho\, V(h_1 + h_2) \text{ ft. lbs.}$$

where, ρ = density of water = 62·5 lbs. per cu. ft. and $V = ax = Sh$ = volume (cu. ft.) of water displaced from the tidal chamber A of cross section a to the outside tidal section B of cross section S ; h being the tidal range, h^1 and h^2, the minimum and maximum water heads (in ft.) respectively. The average power over the entire cycle of period T (mins) is given by

$$P_1 = \frac{1}{2T}\,\rho\, V(h_1 + h_2) \text{ ft. lbs. per min.} \quad . \quad (1)$$

Considering then the gas system we have that the volume of air required to be delivered by the compressor into the chamber A to raise the tide, is

$$C = \frac{1}{p_a}(p_2 v_2 - p_1 v_1)$$

defined at the atmospheric pressure p_a (= 2120 lbs. per sq. ft.). The average rate of delivery of the free air is thus

$$v = \frac{C}{T} = \frac{1}{p_a T}(p_2 v_2 - p_1 v_1) \quad . \quad . \quad . \quad . \quad (2)$$

The power of compressor will be given by the adiabetic compressonal work on v to compress from p_a to p_2 with certain allowance (usually 15 per cent). The adiabetic work is given by

$$P_2 = p_a v \frac{\gamma}{\gamma - 1}\left[\left(\frac{p_2}{p_a}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]$$

$$= 3{\cdot}463\; p_a v \left[\left(\frac{p_2}{p_a}\right)^{0.29} - 1\right] \text{ ft. lbs.}$$

where γ = ratio of specific heats = 1·406 for air. Allowing 15 per cent for losses in the compressor the above formula would be

$$P_2 = 3{\cdot}98\; p_a \left[\left(\frac{p_2}{p_a}\right)^{0.29} - 1\right] \text{ft. lbs. per min.} \quad . \quad (3)$$

The total power is therefore

$$P = \frac{P_1 + P_2}{33000} \text{hp}$$

$$= 9{\cdot}5 \times 10\text{-}4\,\frac{V}{T}(h_1 + h_2) + 0{\cdot}25\left[\left(\frac{p_2}{p_a}\right)^{0.29} - 1\right]$$

v, hp.

For a tidal model of 300 ft. channel, with 3 ft. mean width, 0·33 ft. tidal range, 19 mts. cycle, and having $h_1 = 2$ ft., $h_2 = 1{\cdot}53$ ft., $V = 330$ cu. ft., the power calculates to 0·3 hp. (calculated for the large

tidal model of the Kultigong river, under contemplation).

Although apparently the power required to operate a fairly large model of this size is remarkably small, the practical power which must be handled by the compressor must have to be much larger. This difference is due to the fact that despite the pneumatic chamber taking very low pressure ($p_2 = 1$ to 2 lbs./sq. inch gauge), the air should be stored up in the primary reservoir at much higher pressure, say, 30 or 40 lbs. per sq. inch gauge. Thus the power required of the compressor for the primary storage

$3{\cdot}98\ p_0 v\left[\left(\frac{p}{p_0}\right)^{0\cdot29} - 1\right]$; where p is the storage pressure.

Thus, the total power required for the compressor outfit can be conveniently given by

$$P = 9{\cdot}5 \times 10^{-4}\ \frac{V}{T}(h_1 + h_2) + 0{\cdot}25\left[\left(\frac{p}{p_0}\right)^{0\cdot29} - 1\right] v, \text{ hp.}$$

The compressional power, however, can be readily obtained from the handbook data[3] which gives the power $W_0 = 0{\cdot}25\left[\left(\frac{p}{p_0}\right)^{0\cdot29} - 1\right]$ hp. for compressing 1 cu. ft. of free air to any storage pressure (p) as shown in table I. The compressional part of the work, in the above equation, can be given as $W_0 v$, where v is the average rate of free air delivery given by equation (2). In practice, $W_0 v$ is very large compared with the first term which gives the power to be spent on the water system, so that the choice of compressor is practically determined by $W_0 v$.

TABLE I.

Work done by a single stage compressor.

Gauge pressure lb./sq. inch. (p)	H.P. required to compress one cu. ft. of free-air up to the gauge pressure. (W_0)
10	0·042
20	0·072
30	0·097
40	0·118
60	0·154
80	0·183

Thus, in our previous example, $v = 20$ cu. ft. per min, and taking 40 lbs. as storage pressure, the compressional power comes out to be $0{\cdot}118 \times 20 = 2{\cdot}36$ hp. The power involved in the water system, in this case, is only about 0·1 hp, totalling to 2·46 hp. Allowing generous margin a compressor outfit of 3½ to 4 hp. would be sufficient for such a model.

My thanks are due to Prof. M. N. Saha, F.R.S., and Dr N. K. Bose, Ph.D., for their kind interest during the progress of the work. My thanks are also due to Messrs. N. D. Sen Gupta, M.Sc., and S. K. Mitra, M.Sc., for their helpful discussions and criticisms.

KAMALESH RAY

Palit Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta, 2-5-1945.

[1] Pneumatic Tide-generating Machine—K. Ray, SCIENCE AND CULTURE, *10*, 212, 1944.
[2] Reproduction of a given tide by the Pneumatic generator—K. Ray, SCIENCE AND CULTURE, *10*, 509, 1945.
[3] Mechanical Engineers' Handbook (Vol. II, Power)—Kent

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DEVELOPMENT OF RESOURCES AND INDIAN CONSTITUTION

DURING the last few months the United Nations have been holding a series of conferences, such as the one at Dumbarton Oaks and the other at San Francisco, to determine the principles, the scope, and the functions of a World Security Organization. One of the principal tasks of these conferences, and specially that of the Top Lords, the Big Three, Four, Five and, may be many more in future under the policy of 'grow more powers', has been to determine the kind of government the subject peoples of the world should have. Several systems such as mandates, trusteeship, etc. have been discussed each claiming to give maximum amount of freedom to the subject nations under the prevailing circumstances of their so-called unpreparedness for self-government. This is of special interest to us in India which is the biggest subject country in the world and is under Great Britain, one of the 'Bigs'.

As such, India is now passing through a very critical stage of her political history. The different political parties in India are at present torn off by conflicting ideologies and there is evidently no unity of purpose. Feelings of individualism based on sectarian, religious and provincial prejudices have been far more predominant than those of rationalism. In this confusion, suspicion and distrust of each other have been increasingly manifest. History tells us that a mere declaration of freedom or even attainment of complete sovereignty cannot bring salvation to the masses of the country, when this is followed by the growth of a large number of political and religious parties with divergent aims ; their continued existence undermines the foundations of the State. We have to state *what we have to do and how it can be done*. Orthodox politicians will jeer at us saying that these points will be decided when the freedom is attained. We have a feeling that it is any time a better policy to have a clear and unified programme based upon a critical and analytical study of the circumstances than to put into operation a hurriedly drawn up scheme embodying confused ideas and hasty decisions. That this has been the case in India and even in many other countries, we have not the slightest doubt. Let us take the case of China, our nearest neighbour.

China got rid of the Manchu dynasty in 1911, but nearly for 20 years she could not make any material progress since the successive governments did not know how to utilize this freedom for the uplift of the masses. The country passed through a series of civil and external wars due to greed and lust of power amongst high officials with conflicting ideologies between different parties and jealousies between different provinces. It was only when the late Dr Sun Yat Sen in his *'Three Principles of the People'* laid down a coherent programme of the future Chinese Government that unity of purpose was attained. The War Lords disappeared and the foundation of a modern State which has pledged to Sun Yat Sen's programme of development of resources was laid.

FAULTY CONSTITUTION—A GREAT HINDRANCE TO PROGRESS

The successful and efficient execution of any programme of work is intimately bound up with the constitution of the country. Readers of this journal* are fully aware as to how constitutional drawbacks have hindered progress even in a modern, free, and rich country like the United States. Broadly speaking, in the United States there are two main agencies *viz.*, the Federal Government and the State Governments. The State Governments have under the constitution autonomy in many subjects. When the late President Roosevelt, after his election to the Presi-

* SCIENCE AND CULTURE, *10*, 455, 1945.

dentship in 1933, decided that the Federal Government should undertake large developmental programme as a means of combating the ever increasing effects of unemployment, it was found that the American Constitution which gave a large amount of such functions to the autonomous States stood in the way of a planned programme on a regional basis. A man less resolute than President Roosevelt would probably have sought peace by talking with a double voice, or adopting a cold storage policy as is usually done in this country, and would have found ready excuse in constitutional drawbacks for inactivity. But President Roosevelt with characteristic foresight, courage and statesmanship, tackled the monster of unemployment by cutting through these constitutional barriers, and wherever the interests of the common man in the U. S. A. demanded it, he never hesitated to ride rough over prerogatives of individual States and replace it by federal initiative. Thus the TVA, the first successful experiment in large-scale regional planning, was created in 1933. By now our readers have formed a fair idea of the achievements of this organization which, by harnessing a wild and turbulent river, has converted this basin into one of the most prosperous regions of the United States and has played such an important part during the present war by providing enormous power for war industries.

Another example* is that of the Murray River in Australia. This River covers three States and although schemes of its development specially for the production of hydro-electric power had been formulated nearly 20 years ago, they could not be put into operation on account of the lack of co-ordination in the policy of the different States, (Victoria, New South Wales and South Australia) due to their autonomous rights. These examples clearly demonstrate how a faulty constitution can retard progress even in independent countries.

We offer no apology for having again taken up the case of rivers to illustrate our point. In the past, rivers were mainly used for irrigation and navigation, and were held in great esteem. But never before have rivers played such an important part in the economy, development and general prosperity of a nation as during the present century, specially after the development of the hydro-electric power. Power is *sine qua non* of all material development and a river is the greatest and inexhaustible asset for the production of power. It will not be incorrect to say that the potential productive capacity of a country and consequently her material progress can be judged from her river resources. After the creation of the TVA and its achievements, the river has now assumed the role of a multi-purpose agency and has become one of the biggest source of power as is evident from the following extract:[1]

"No major river in the world is so fully controlled as the Tennessee, no other river works so hard for the people, for the force that used to spend itself so violently is today turning giant water-wheels. The turbines and generators in the TVA powerhouses have transformed it into electric energy. And this is the river's greatest yield."

"What the TVA, in specific ways, has sought to do can be simply stated: to accept an obligation to harmonize the private interest in earning a return from resources, with the dominant public interest in their unified and efficient development. The method—and this is the distinctive part of the experiment—is to bring to bear at the grass roots the skills of public experts and administrators not for negative regulation but to make affirmative action in the public interest both feasible and appealing to private industry."

These lines clearly indicate how a wild and uncontrolled river can be made a source of material prosperity, which otherwise is a potential source of devastation, misery, poverty and disease. The rivers are not subject to any political prejudices and provincial boundaries. They flow and flow freely. Their development requires a co-ordinated plan not only of the different aspects of unified development, but also of the different regions covered by the river. It is here that provincial and other barriers stand in the way of progress. When a river flows, the different parts that it covers are affected to different extents and in different ways. For instance, the upper areas are subjected to a great deal of erosion of soil, and the lower areas are subjected to occasional floods whereas some areas are benefited by the deposition of fertile soils. It is only one agency which can take into account the disadvantages suffered by different people and work out a plan of integrated development.

Constitution in India

The present century has occasionally been characterized as a period of gradual constitutional development in India. For instance, the Morley-Minto reforms, the Montague-Chelmsford reforms and the latest Government of India Act, 1935. These reforms have been the result of political agitations in India demanding self-government and in the framing of these constitutions, the alien paramount government has been concerned more with satisfying the communal, provincial and vested interests than with the adoption of a constitution whose primary aim would be the solution of the economic problems of the country.

Let us look at the constitution of 1935. The very fact that it was based on separate electorates effected on religious basis and vested interests makes it abundantly clear that in its framing, it were the

* K. Ray, Murray River Commission, Science and Culture, *10*, 461, 1945.

[1] Lilienthal, D. E., TVA Democracy on the March(p. 16, 1944.

communal and provincial passions rather than considerations of economic development which played the fundamental rôle.

The constitution has four important aspects: (1) the All-India Federation, (2) the Provincial Autonomy, (3) the Safeguards and (4) the Central Responsibility. Under the provincial autonomy[2] the question of development of industries, water power resources, waterways, irrigation, agriculture, etc. were classified as provincial subjects. As has already been shown in the columns of this journal[3] this relegation of these important developmental subjects which was based more on communal and provincial feelings, to provincial authorities has constituted one of the major bottlenecks in organized development. The communal basis of the division of activities is evident from the speech of Sir S. Hoare[4] in the Parliament on the Government of India Act, 1935.

"If it had been possible to have one list we should have been glad, but, unfortunately, as in many of these Indian problems, when we came to apply to the actual facts what we desired, we found it to be impossible. We found that Indian opinion was very definitely divided between, speaking generally, the Hindus who wish to keep the predominant power in the Centre, and the Moslems who wish to keep the predominant power in the Provinces. The extent of that feeling made each of these communities look with the greatest suspicion at the residuary field, the Hindus demanding that the residuary field should remain with the Centre and the Moslems equally strongly demanding that the residuary field should remain with the Provinces."

The Joint Parliamentary Committee[5] had envisaged some kind of overriding provision in all-India matters.

"Experience has shown, both in India and elsewhere, that there are certain matters which cannot be allocated exclusively either to a Central or to a Provincial Legislature, and for which, though it is often desirable that provincial legislation should make provision, it is equally necessary that the Central Legislature should also have a legislative jurisdiction, to *enable it in some cases to secure uniformity in the main principles of law throughout the country, in others to guide and encourage provincial effort, and in others again to provide remedies for mischiefs arising in the provincial sphere but extending or liable to extend beyond the boundaries of a single Province.* Instances of the first are provided by the subject matter of the great Indian Codes, of the second by such matters as labour legislation, and of the third by legislation for the prevention and control of epidemic diseases. It would in our view be disastrous if the uniformity of law which the Indian Codes provide were destroyed or whittled away by the unco-ordinated action of Provincial Legislatures. On the other hand, local conditions necessarily vary from Province to Province, and Provincial Legislatures ought to have the power of adapting general legislation of this kind to meet the particular circumstances of a Province."

[2] C. L. Anand, Government of India Act, 1935, Seventh Schedule List II, 558-562.
[3] SCIENCE AND CULTURE, *10*, 455, 1945.
[4] C. L. Anand, *ibid.*, p. 255.
[5] C. L. Anand, *ibid.*, p. 255.

POOR FINANCES OF SOME PROVINCES

In India, this has a special significance since the finances of the individual provinces and specially those of the small ones are poor, and as such they are not in a position to undertake any major programme of development. In fact, these difficulties were evident when some of the new autonomous provinces were constituted at the time of framing the 1935 Act.[6]

"We are informed that it is now anticipated that the new Province would start with an initial yearly deficit of about ¾th crore, which would be gradually extinguished in about 15 years and that about after that period the Province should be able to dispense with assistance."

Moreover, sometimes questions of provincial vanity and individualism induce the provinces to undertake measures which amount to nothing short of duplication. It is natural that in so doing their finances are exhausted and the results are comparatively insignificant. This has been felt in several aspects of provincial administration, such as industries, education, health, agriculture, etc. Some of the problems of different provinces are likely to be of the same nature, and they can best be solved with better resources both financial and that of personnel if they are done on a co-ordinated basis. The results of these confusions were recently demonstrated in the Bengal famine when, for considerable time, the Central and the Provincial Governments went on discussing the spheres of their activity and responsibility meanwhile hundreds of thousands perished for want of a handful of rice. Due to the too rigid provincial system, the provincial rivalries have been rampant and this has been amply demonstrated in the continuous decrease in the efficiency in the recruitment of services, since the provincial governments to satisfy their voters are compelled to give preference to provincial personnel.

I.C.S.—AN OMNIBUS CLASS OF SERVICE

A very unfortunate aspect of this constitution is the reservation of several important posts for the Indian Civil Service who are a rigid caste by themselves like the Brahmins. Nobody even with greater and authoritative knowledge of the subject can be smuggled into their sphere. In England, for example, the person, when he has become a Civil Servant, has to choose a subject for his later professions whether he is to become a financial adviser, an administrator, an economist, an engineer etc. In India he can be anything—a district magistrate, a director of industries, a district judge, a trade commissioner, a financial adviser or even war controller of Persian Gulf. This system makes him a jack of all trades but master of none. It is natural, therefore, that, when he is put in charge of several

[6] C. L. Anand, *ibid.*, p. 199.

controls, say food, cloth, transport, etc., there is an utter confusion not due to the lack of interest but on account of the lack of knowledge which alone can enable him to handle the position in which he finds himself. The result is chaos, famines, shortages etc. According to the Government of India Act, no outsider can be called to fill up these posts except as adviser who has very little executive power.

In the U. K. and U. S. A., Civil Servants can be recruited from amongst the outsiders and be given the same privileges as the permanent civil servants. This system has been particularly helpful in ensuring the services of properly trained persons for many of the technical posts. There being no age restrictions, the practice of recruiting men at a comparatively advanced age ensures the benefit of long experience and mature judgment.

Partition of India

Of late, the religious rivalries tending towards fanaticism have given rise to a very dangerous outlook which threatens the very existence of India as a nation and that is the cry for its partition into two States based on a prepondering population professing different religions. It is absolutely unconnected with the reality of the situation and, if brought about, will make this unfortunate land a permanent wreckage and a place of famines, misery and disasters. Various schemes have been put forward as an alternative to this demand and the most recent is the one advocated by the Sapru Conciliation Committee. But all these have failed to take any account of the development of resources of India which alone can assure prosperity to her masses, since they are all based more on sentiments than on any critical and scientific analysis of the circumstances. To the Muslims, freedom for India appears a Hinduraj and their subordination, to the Hindus, it means their being reduced to a minority, to the scheduled caste, it means domination by the caste Hindus ; to some extremists freedom lies in gaining some percentages in services. Under this confusion, the central fact of the coordinated development of natural resources on strictly nationalistic lines is completely lost sight of. What else but poverty and misery can the poor heirs of a poor man get after division? The extreme poverty of the country is a glaring reminder that a mere increase in the allotment of services by 1 per cent or 2 per cent. cannot solve the eternal problem of the masses of India. A poor man will remain poor whether he gets 30 per cent or 33 per cent.

Is there Pakistan in the U.S.A.?

Recently the Hon'ble Dr B. R. Ambedkar put a very clear question to Prof. M. N. Saha after his return from the U.S.A., whether as a result of his experience in that country whose geographical position and distribution into several States having inhabitants claiming different nationality, religion and colour at the time of their settlement, he could say if there was any problem like Pakistan. His remarks are really very interesting and are quoted below.

"There is absolutely no such thing in the United States, and in fact the very idea was severely opposed when once the Southern States wanted to secede from the Union, President Abraham Lincoln said "We shall prefer to have a hundred years of civil war than a cessation of some of the States from the Union." If Lincoln had not taken this bold stand and if the North was lost to the South, the process of disintegration would not have stopped there but the U. S. A. would have been divided into a large number of small autonomous States each fighting its neighbours and would have reduced to something like the small States in Latin America."

Development possible only by Maintaining the Unity of Resources.—Regional System

Latin America consists of a number of States Chile, Peru, Argentina, Venezuela, Equador, Columbia, Bolivia, Uruguay, Paraguay, etc. Chile has copper and salt ; Venezuela has oil ; Bolivia has tin and tungsten ; Argentina has enormous resources for beef, but none of them has resources nor finances to develop these individually and so they are exploited and developed by outside agencies who are far more powerful than any of these small States. If they would have been one unit, they would have made a great country like the U.S.A. For instance, if Punjab and Bengal secede from India, as proposed in the Pakistan scheme, Bengal will have jute, bamboo and banana, and Punjab would have to depend on wheat and the professional soldiers. None of these autonomous States, howsoever well situated, can have resources for self-sufficiency and will have ultimately no chance of surviving in a modern world. But if India remains together, she has all the potentialities and resources of developing into a powerful State like Russia and America.

Of late some of our leaders are advocating the idea of self-sufficiency and they have gone to such extremes that they consider that each village, not to say of provinces, should produce all its needs. What a fine imagination indeed! And what indifference to realities! Some of these schemes and programmes have made the situation in India very confusing and it is essential that this confusion should soon be removed if we are not to be permanently thrown to serfdom.

If under the name of autonomy provinces are allowed to develop into separate and unco-ordinated units, we shall be putting obstacles in the path of progress and ultimately the provinces will be terrible sufferers, signs of which are already apparent. For example, it has been shown that the rivers of India

are capable of producing enormous amount of power for irrigation, navigation, transport, industries, etc. The potential power resources of some of the Indian rivers, for instance, the Ganges, and the Brahmaputra, are stated to be even better than that of the American rivers. The Tennessee Valley, with a basin of 40,600 sq. miles, produces 12,000 million kw. which is 3-4 times the total production of India. One can imagine the huge power that can be produced by harnessing the Indian rivers. Many of the rivers pass through more than one province. The Punjab rivers can only be developed with the prior permission of Kashmir and the other States: if Mysore has to make use of the Cauvery, there must be an understanding between Mysore and Tanjore ; if the Damodar has to be developed, which has been very much talked about in recent years, the co-operation of the Bengal and Bihar Governments is necessary. This can only be done if the Central Government takes charge of these developments by creating *multipurpose regional agencies,* and that is the only way of maintaining the unity of resources which is a pre-requisite to organized development. This has been clearly demonstrated by the experience of the TVA, as is evident from the following extract[7] :

"But such a moral purpose alone is not enough to insure that resource development will be a blessing and not a curse. Out of TVA experience in this valley I am persuaded that to make such a purpose effective two other principles are essential.

First, that resource development must be governed by the unity of nature herself.

Second, that the people must participate actively in that development."

"Is it inescapable that such a task of resource development be carried on only by highly centralized government direction? Must it inevitably be run by a privileged elite of managers or experts or politicians? Yes, say the defeatists about democracy, the cynics, the disillusioned and frustrated liberals, the believers in force, the disbelievers in men. Can it be done in no other way than by gutting the resources of nature, by making the countryside hideous, by maiming the forests, fouling the streams, ignoring the unity of land and water and men? Yes, that is 'the way things are', say the greedy, the short-sighted, the unperceptive.

The experience in this valley gives the lie to such answers and to those who utter them. The whole point of the TVA experience that I shall seek to make plain in this book is that the best way, perhaps the only way the job can be done effectively is by observing the unity of nature, by following democratic methods, by the active daily participation of the people themselves."

"To a single agency, the TVA, these potentialities of the river for good and evil were entrusted. But the river was to be seen as part of the larger pattern of the region, one asset of the many that in nature are interwoven: the land, the minerals, the waters, the forests—and all of these as one—in their relation to the lives of the valley's people. It was the total benefit to all that was to be the common goal and the new agency's responsibility."

"The unity of nature's resources must not be disregarded, or the purpose for which such developments are undertaken will be betrayed as it has been betrayed before: by the way the job is done."

Conservation of Resources

In modern civilization, the abundance of natural resources plays a very fundamental role in the life of a nation. Consequently in the advanced countries the adoption of measures for the conservation of irreplaceable resources, such as minerals, fuels, etc. so essential for industrial development, is now being vigorously advocated as a matter of national policy. If one goes deep, many of the present day rivalries amongst the big powers can be traced to the possession of irreplaceable key resources. The controversy over Iranian oil is a recent example. The measures for the conservation of such resources can only be effective if planned on the basis of the entire country and put into operation under a co-ordinated system. This, by the very nature of the problem, cannot be achieved by individual provincial units due to their limited spheres of activity.

Take, for instance, the question of electric power which is produced by utilizing the water power resources or the fuels. In a country poor in fuel resources, the production of power by utilizing water resources should naturally be given preference to the thermal process. Now, if the province possessing the water power resources is also a big producer of fuels, it will hinder, if it can as is the case under the present autonomous system, the utilization of water resources under the pretext of the decline of its own fuel industry. Under such conditions, the natural resources of one type which are replaceable will be wasted, whereas the resources of the other type *i.e.* the fuels, which are irreplaceable will dwindle. The obvious result is the depletion of irreplaceable resources leading to dependence on other countries. The logical procedure under a unified system based on the interests of the whole country will be to utilize the hydro-electric resources and conserve the irreplaceable fuel resources. That this has actually been the experience, although not exactly similar, is evident from the following lines[8] :—

"There was at the outset bitter opposition to the TVA from the coal industry, an opposition which further illustrates how mistaken it is to cling to the ideal of restricted development. The argument was made that by developing electricity from the water of the river TVA would rob the coal industry of its existing market for coal for steam-generated electricity."

It is thus clear that this system of leaving such developmental subjects to the provincial sphere is very detrimental to a proper conservation and harnessing the resources of a country and is likely to lead to their waste and depletion. The results of such a practice are too obvious to be discussed.

[7] Lilienthal, D. E., *ibid.*, p. 6, 49 & 57.

[8] Lilienthal, D. E., p. 209.

Vague Provisions in the Government of India Act, 1935

In the seventh schedule to the Government of India Act, 1935, the spheres of the Federal and Provincial Legislature, both separately and concurrently, are laid. Although there is a provision[9] for the Centre to make laws when the interests of some provinces demand it, they appear to us to be vaguely defined and do not clearly lay down when, where and to what extent the Centre can intervene where such a course is desired.

"If it appears to the Legislatures of two or more Provinces to be desirable that any of the matters enumerated in the Provincial Legislative List should be regulated in those provinces by Act of the Federal Legislature, and if resolutions to that effect are passed by all the Chambers of those Provincial Legislatures, it shall be lawful for the Federal Legislature to pass an Act for regulating the matter accordingly, but any Act so passed may, as respects any Province to which it applies, be amended or repealed by an Act of the Legislature of that Province." (Government of India Act, 1935, Sec. 103, Power of Federal Legislature to legislate for two or more Provinces by consent).

For instance industries appear both in Federal list and Provincial list. The actual words are :—

"Development of industries, where development under Federal control is declared by Federal law to be expedient in the public interest." (List I . . ., p. 34).

"Regulation of mines and oil-fields and mineral development to the extent to which such regulation and development under Federal control is declared by Federal law to be expedient in the public interest." (List I . . ., p. 36).

"Regulation of mines and oil-fields and mineral development subject to the provisions of List I with respect to regulation and development under Federal control." (List II, p. 23).

"Production, supply and distribution of goods; development of industries, subject to the provisions in List I with respect to the development of certain industries under Federal control." (List II, p. 29).

Under these circumstances it becomes very difficult to fix responsibility for initiative and if at all some move is contemplated the question of demarcating respective spheres of Provincial and Central Governments leads to interminable discussions providing circumstances for inactivity. Under the present structure of Government, it will be too optimistic to expect a bold initiative from the Centre.

Basis of the Constitution

The foregoing considerations inevitably lead us to the conclusion that *the basis of all constitutions should be a system designed to facilitate the development of natural resources,* since it is on this development carried out under strictly democratic principles that a decent and comfortable living to the masses can be assured. We have to accept that *India is an indivisible economic unit* and any idea of partitioning it into different zones based on religious sentiments will be to throw the entire population into permanent bondage and misery whether it be in the Hindu zone or the Muslim zone. In the future world, it is the master of properly developed resources who will be the dominating power, and countries divided into unco-ordinated units, although literally free, will remain a subject nation *de facto.*

Decentralized Administration of a Central Authority

This discussion of treating the important developmental subjects as Central does not imply that we advocate a highly centralized administration of these subjects. There are two things quite distinct from each other, namely the *authority* and how that authority works, *i.e.* its *administration.* The authority must be central so that a unified policy taking into consideration the potential resources, the best way of their development and the needs of the people of the different areas can be laid down, but its execution must be done through the local people or what we may call local agencies if it has to avoid the consequences of ignoring realities. At least in the development of resources, this system has yielded rankable results as is evident from the experience of the TVA.[10]

"The distinction between authority and its administration is a vital one. For a long time all of us—administrators, citizens, and politicians—have been confused on this point. We have acted on the assumption that because there was an increasing need for centralized authority, the centralized execution of that authority was likewise inevitable. We have assumed that, as new powers were granted to the government with its seat at Washington, these powers therefore must also be administered from Washington. Out of lethargy and confusion we have taken it for granted that the price of federal action was a top-heavy, cumbersome administration. Clearly this is nonsense. The problem is to divorce the two ideas of authority and administration of authority."

"For a federal agency to 'work itself out of a job' in this way requires, among other things, that the state or local agency be given credit very generously for its part in these joint enterprises. Popular support depends upon it, and appropriations are difficult to secure, and inevitably dwindle and even disappear."

These experiences of the biggest single regional agency in the field of resource of planning should be a good lesson to us in view of the similarity of our problems of resources development. The mere transfer of a subject to the provincial sphere cannot ensure a proper development. *The Central Government must have the authority to make unified plans, and enact laws for developmental subjects on an all-India basis but the execution of the plans must be done by the Provinces under co-ordination by the Centre.*

If four freedoms which are being much talked of have any real significance for dependent countries,

[9] C. L. Anand, *ibid.*, p. 258

[10] Lilienthal, D. E., *ibid.*, p. 143, 131.

then the basis of constitution should be, as indicated by us, the development of resources on a national scale based on material interests which alone can ensure these freedoms. We are no Pundits of constitution but we feel that men of science can be helpful in giving guidance to our politicians who are torn off by conflicting ideologies in arriving at a rational basis of constitution. Science is now no more a profession of funny men. It is a force which cannot be ignored in any scheme of development, economic or political ; and it is only reasonable that it should have a hand in framing the constitution of the country which should be based on scientific understanding of the problem. If therefore we are to frame a constitution which should allow maximum scope for the development of our resources we suggest the following points for consideration :

(1) India is an indivisible unit and in order to raise the standard of living her unity is essential as a condition precedent to the proper development of her resources, which alone coupled with equitable distribution of earned wealth can ensure prosperity to her teeming millions. It is feared that under the stress of communal, religious and sectarian passions, which aim at her partition, her very future when free, is at stake. Thus one step will make all the difference between her becoming a first class power when free for which she is endowed with all the resources, and permanent economic serfdom as is the case with some of the Latin American countries. For an organized development of resources the unity of natural resources should not be destroyed simply to satisfy communal passions which are the creation of a few with no connection whatever with the real problems of the masses.

(2) Important items of development like industries, waterways, irrigation, development of power, transport, soil conservation, etc. should be under Central Authority. But it is not implied that provinces should be robbed of their share in this development. We are opposed to highly centralized system as being another form of top heavy and clumsy administration of a central authority which should ensure a unified policy for the whole country but carried out by different units in co-operation with each other.

(3) There should be a full scope in the constitution for the establishment of multipurposes Regional Autthorities like the TVA for the development of resources.

(4) The Indian Civil Service should not be kept a rigid monopoly of a certain class of people but should be thrown open to outsiders for special subjects. This will ensure a better working of some of the specialized projects for which the civil servant as he exists today is not at all suitable.

We do not claim any finality of the discussion on the constitutional aspects and leave the actual framing of the constitution to the constitutionalists of the country, but earnestly hope that these aspects will find a full scope in our future constitution so that the development of our resources may be undertaken more rapidly. Without this it will be idle to talk of planning and much more so of development, since these prejudices and provincial rights are hampering the progress of even the preliminary work. We therefore invite the attention of our planners to these constitutional aspects of planning.

TENNESSEE VALLEY AUTHORITY

W. L. VOORDUIN,

HYDRO-ELECTRIC MEMBER, CENTRAL TECHNICAL POWER BOARD, GOVERNMENT OF INDIA.
FORMERLY HEAD PLANNING ENGINEER, T. V. A.

IT can safely be assumed that the main reasons for the active interest of a large portion of the Indian people in the development of the Tennessee River, situated roughly half way around the world from India, are their concern about their own future and their belief that by its practical example the unified development of the Tennessee Valley will affect their own destinies. It is important, therefore, that the leading elements of the people, the scientists, politicians, technicians and businessmen should know what has happened there.

Fundamentally, the T.V.A. was set up as a "Pilot plant" to throw the light of actual experience on the development of *all* the resources in a river valley, and not just one or two of the resources, and the T.V.A. was to serve *all* the inhabitants of the valley and not just a few special interests. In the past the Federal Government had undertaken, time and time again, the construction of separate works for navigation or flood control or power. Bringing all the responsibilities together in one agency, this unity was new and different, never tried before in history. The combined responsibility given to the T.V.A made it possible to have the solution of one problem

dovetail with, and not interfere with, the solution of another problem.

Modern engineering methods are used as the means to obtain the end result, *i.e.* engineering skill is utilized to construct and operate the works which make *an improvement* in the general welfare of the people possible. Besides the Engineering Department, which directs its energies towards the planning, design and construction of the water control works in the river channels, and the Power Department, which operates the power system, the T.V.A. has departments mainly concerned with agriculture, forestry, chemical engineering, health and safety, commerce, reservoir property management, as well as a Personnel Department, Finance Department, Legal Department and Supply Department. The management of all the interrelated tasks of the various departments is vested in a three-man Board of Directors assisted by a General Manager and General Counsel, a budget staff and an information service. The Board of Directors is appointed by the President of the United States by and with the advice and consent of the Senate.

During the now almost exactly twelve years of its existence, the T.V.A. has completed the construction of seven dams on the main Tennessee River and nine dams on the tributaries as well as one large thermal electric station. Together with two main river dams, four tributary dams and five thermal stations already in operation in the region at the time of the creation of the T.V.A., the system now consists of twentyeight major plants and an additional thirteen small plants also owned and operated by the T.V.A. The largest single project of the T.V.A. is the Kentucky Dam at the mouth of the Tennessee River recently completed at a total cost of about 35 crores of rupees. This dam is about 8,500 ft. long and has a maximum height of 165 ft. The lake formed by the dam has a shore line of 2,200 miles, covers an area of approximately 160,000 acres, and has a total storage capacity of roughly 6,100,000 acre ft. The largest dam on the tributaries is the Fontana Dam on the Little Tennessee River now practically completed at a cost of perhaps some 20 crores of rupees. The dam is 2,300 ft. long, its maximum height is 460 ft. The lake covers an area of about 11,000 acres and its total storage capacity is almost 1,500,000 acre ft.

The system of T.V.A. reservoirs, with a total storage capacity of 22,000,000 acre ft., controls the floods and regulates the flow of a large and turbulent river with a drainage area of 40,000 sq. miles. A navigable channel for river craft with a 9 ft. draught is provided for a distance of 650 miles from the mouth of the Tennessee River to Knoxville, Tennessee. The total generating capacity authorized for installation at the dams and thermal electric stations is about 2,850,000 KW of which more than 2,000,000 KW is now installed. The total length of transmission lines is about 6,000 miles of which more than 90 per cent carries a voltage of 44 kV or over. The highest transmission line voltage is 154 kV. The area covered by the transmission lines extends for a distance of 400 miles from east to west and about 200 miles from north to south. The generating stations are scattered throughout this area, the longest 154 kV line between stations is approximately 150 miles. The net generation has grown from 400,000,000 kilowatt-hours during the fiscal year ended June 30th 1934 to more than 10,000,000,000 kilowatt-hours during the year ended June 30th 1944, a growth of twenty-five times the original load in 10 years.

The T.V.A. delivers energy to industries, neighbouring utilities, and to municipalities and co-operatives, who distribute the energy to residential and rural customers in the T.V.A. area. Energy to the municipalities and co-operatives is delivered at the sub-stations at a rate of about 2·7 pies per KW hour. Contracts with the municipalities and co-operatives who own and operate the distribution systems allow a substantial increase about this rate to be charged to the residential customers, but any surplus accumulated about interest on bonds and operating expenditures can only be used for improvements or extensions to the distribution systems or to retire the bonded indebtedness. Many of the co-operatives are now practically debt free and can contemplate a reduction in rates. The surplus cannot be used to reduce the normal running expenditure of the municipal governments because if this were permitted, such surplus would reduce taxes and by doing this the principle of taxation to charge in accordance with the ability to pay would be upset.

In the operation of the system of power plants the guiding factor is the requirement of flood control, *i.e.*, prior to the winter season from December to March, when the major floods occur, the reservoirs are emptied to pre-determined levels and as the danger of floods becomes less during this season, they are partially refilled. After the danger of large floods has passed the refilling of the reservoirs is continued depending upon the amout of stream flow available for this purpose. During the following dry period of the year the amount stored in the reservoirs is released for minimum flow regulation for power and navigation purposes.

Even after regulation by the reservoirs, more power is available from the system of hydro-electric plants in a year of average stream flow than in a year of minimum stream flow. Steam plants with an installed capacity of more than 400,000 KW are available to equalize the load carrying capacity of the

system between the different types of stream flow years. During the dry portion of the year the reservoirs are operated in accordance with a pre-determined set of rule curves for each reservoir which, in conjunction with the predicted load in the immediate future, serve as a guide to determine the amount of steam capacity which has to be placed in operation.

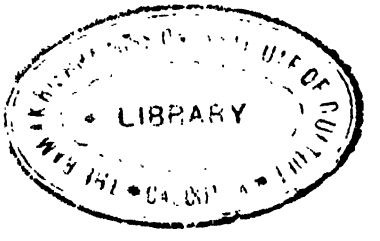
The T.V.A. obtains its funds for the construction of the works by appropriations from the Federal Treasury and it is expected that the total investment will be in the neighbourhood of Rs. 250 crores. I believe that it would be fair to say that the financial returns of the undertaking are quite favourable. At the end of the fiscal year 1943 when the program was roughly two-thirds completed, the total investment in completed plant amounted to approximately 165 crores of rupees. Of this amount roughly Rs. 25 crores were allocated to navigation, Rs. 13 crores to flood control, Rs. 7 crores to fertilizer and general plant, and the remainder of Rs. 120 crores to the power development. The gross power revenue for this fiscal year amounted to Rs. 10½ crores. After deduction for operating expenses, depreciation and amortization, the net revenue amounted to approximately Rs. 4·4 crores and this corresponds roughly to a return of 5 per cent on the average net book value of the power plant during the fiscal year. If the computations were to be based on the net book value of the entire plant at the end of the fiscal year (including investment in navigation and flood control facilities) the computed return would be approximately 3 per cent.

In appraising the financial returns it should be remembered that these returns for an enterprise of this nature are not an adequate criterion of success. The final test of the success of a Government enterprise on this scale lies in the improvement of the general welfare of the people as a whole. Much of the investment is of such a nature that only indirect benefits can reasonably be expected. For instance, the expenditure made for malaria control or flood control could not be expected to give returns other than in improved health and welfare. A reasonable parallel can be drawn by the average householder with the bills which he occasionally pays to his doctor or for the repairs of a leaking roof on his house.

The question is frequently asked "What will happen at the end of the war". Of course nobody can give the complete answer to that question, but there are some facts which can be stated with certainty. Some of the dams which were planned for multi-purpose development have temperorarily, during the period of war emergency, been used to produce a maximum amount of power and these dams will upon the cessation of hostilities revert to their normal multi-purpose functions. In addition, and if the drop in load should exceed this reduction in availability of power, then the thermal electric stations would be closed down so that the reduction in revenue would be offset by a substantial reduction in operating expenses due to coal savings. In this manner the load could drop by a very substantial figure before other measures would be necessary. These other measures could be contracts with neighbouring power systems to supply power so that these systems could shut down their thermal electric stations. In this way it seems quite certain that in the future no power, which can be generated at the hydro-electric stations, will be wasted.

In taking a broad view of the possibilities of development of this nature in India, there are two points which stand out. These are the requirements for irrigation, and the greater density of population in this country. In the T.V.A. area no irrigation is required, while in this country irrigation would be one of the major purposes of water control projects. This added function would make a multi-purpose development much more valuable, particularly because the interests of power and irrigation are not in conflict with each other. Possibilities for power development generally occur in the upper reaches of a river where the rainfall is the heaviest, and where a substantial head is available, while possibilities for irrigation generally occur in the lower and flatter reaches of the river. Irrigation can thus utilize the regulated flow made available from the power development. Thereby, there would be at least two paying partners instead of only one as is the case in the T.V.A. The density of population is many times greater in this country than it is in the United States and this generally also holds true for the river valleys in each country. Similiar undertakings covering the same area in both countries would, therefore, directly benefit more people here than would be the case in the United States.

Developments of this nature are worthy of serious consideration by all elements of the people. India's future will depend in a large measure upon what will be done with its undeveloped river valleys.


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PROBLEMS OF ANIMAL POPULATION AND MIGRATION RESEARCH IN INDIA : NEED OF A CENTRAL INSTITUTE*

M. L. ROONWAL,

ASSISTANT SUPERINTENDENT, ZOOLOGICAL SURVEY OF INDIA

INTRODUCTION

ANIMAL populations are never constant. They are in a continuous state of flux. The truth of this phenomenon has been known to mankind since ages, not, however, as a result of patient, painstaking research, but because certain species like locusts, lemmings and voles took into their head, so to speak, of multiplying periodically in such vast numbers as to invite man's anxious attention. These hordes swarm, migrate to enormous distances and sometimes meet their doom in this process. Thus, thousands upon thousands of Norwegian lemmings periodically march over hills and dales and plunge into the sea to perish. Similarly, locust swarms have been known to be drowned in the sea. Gradually it comes to be realized that apart from these spectacular fluctuations, animal populations fluctuate in a smaller but no less certain way. These fluctuations rather differ from plagues in degree (being less spectacular) and are perhaps rather more regular. In several species that have been closely studied, definite periodicities varying from two to eleven years or more, have been established in the population flux. For example, the Desert Locust, *Schistocerca gregaria* (Forskal) has, on the average, an eleven year periodicity, though individual plague periods have sometimes recurred after as short a period as two years.

Once the existence of natural fluctuation has been established in a species, the next step is to seek for its causes. The line of attack is twofold, along what we may describe as the external and the internal approach. The *external approach* concerns the "environment' which includes both the living (animals and plants) and the non-living (climatic) components. The first may be dramatically and rather crudely, but nevertheless fairly truthfully, illustrated by the following sequence of events: The cow eats grass ; the tiger kills the cow ; man kills the tiger ; malarial parasite kills man. So that if man stopped killing tigers either by his own will or because malaria had rendered the majority of the population so weak as to disable it from killing tigers, the latter would increase so much in number that the cow population would be in grave danger. With this we may interweave the second aspect as well. When the monsoon fails in the desert areas of Western India and the grass dries and the land is parched and there is hardly a drop of water to drink, thousands of cows die, and so do other animals. The farmers migrate south to the more hospitable tracts of Malwa, leaving in their trail carcases of cattle which became exhausted and fell on the way. Under these conditions tigers, even though they do not eat grass, would decline in number for there is less food, cows being fewer. This, in brief, is the simplified relationship. In actual practice, however, the problem is extremely complicated, and many more factors have to be closely studied before reliable conclusions can be drawn. What factors in the climate affect the population is not always known ; and different species may be affected by different factors or diverse degrees of the same factor. High temperature may kill the animals outright, or it may reduce the reproductive rate. Severe winter preceded by rain may kill thousands of birds in a locality, even though our feathered friends are well insulated against excessive loss of heat. One can go farther and attempt to correlate population fluctuation with sun-spot cycle, as some have done (not very successfully) in the belief that sun-spots govern the earth's climate. Or, again, a wave of epizootic disease (*e.g.*, bubonic plague) might devastate a population of rats. And many other similar things might happen. But enough has been said to show the nature of the problems which deserve close scientific study.

The method of *internal approach* is, in one word, mathematical-experimental. The purely mathematical approach began some twenty years ago when the classical Lotka-Volterra dynamics were formulated. In 1925 Lotka, an American mathematical expert on human population dynamics, and about the same time Volterra, an Italian mathematician, showed by rigid mathematical proofs that periodic oscillation is *inherent* in groups of ecologically linked species. Climate merely interferes with this natural rythm, producing complex interrelationships. Students of animal population now believe that the Lotka-Volterra dynamics are fundamentally correct. The experimental approach has been developed mainly in America and intensive work done chiefly on insects like the flour-beetle, *Tribolium*, which lends itself to easy culture under standardised conditions. These experiments have shown that, irrespective of the environment, populations are self-regulatory, an increase inevitably leading to a decline even though the food is abundant and no apparent toxic conditions and disease present.

* Published with the permission of the Director, Zoological Survey of India.

Population Work in Other Countries

The introductory part was intended to define the general nature and emphasize the complexity of the population problem. Having done so, let us take a quick glance of what the progressive world is doing about these problems. I shall confine myself to the study especially of mammal and bird populations in four countries only, *viz.*, the United States, Russia, Great Britain, and Germany, and, finally, demonstrate the pitiful neglect of the subject in India.

In the United States powerful organizations exist for the study of mammal, bird and fish population and migration. The chief of these is the Fish and Wild Life Service (formerly the Bureau of Biological Survey), a huge Federal organization with many laboratories, experiment stations and migration observatories and hundreds of biologists on the staff. From all angles its staff studies mammal, bird and fish ecology and population. To supplement this, is a great network of Universities, State Experiment Stations, Museums and private laboratories where such studies on vertebrate populations, not to speak of those of insects, are carried out. The sums spent in these investigations and the resulting output of knowledge are colossal.

The U.S.S.R. is a close competitor of the U.S.A. in the matter of animal population research and allied ecological problems. Much of this undoubtedly first rate work is not known to outsiders, even outside scientists, owing largely to barriers of a political and linguistic character. In India, we are almost completely ignorant of the vast amount of Russian zoological research. The loss is ours. Of Russian population research, that on mammal and insect populations is perhaps the most extensive. There is a marked tendency to seek for the causes of population fluctuation in climate, and experimental work on the American model is not yet much in vogue. The Russians lay great stress on population work for they rightly believe this to be of great economic value in the control of vertebrate and invertebrate agricultural pests, in the study of vertebrate reservoirs of diseases and in the sound development of fisheries. The institutions doing population research are as multifarious as, perhaps more so than, in the U.S.A., and almost all are post-revolution (1917) creations of the Soviet regime.

British research on animal population, in the modern sense, is also comparatively recent, being about 20 years old. It owes a great debt to Charles Elton of Oxford who is a pioneer of that research in Great Britain. For years this intrepid zoologist has been carrying on, often against considerable odds, population research on mammals and has succeeded in establishing at Oxford a Bureau of Animal Population of which he is the Director. In 1942 he published a fascinating monograph called *Voles Mice and Lemmings: Problems in Population Dynamics.* In the main trend, British research is similar to Russian work, but the methods employed are somewhat more elaborate. Elton's work on population cycles of fur animals of Northern Canada is an excellent instance of what can be done by a critical examination of old archives.

German research on animal population dynamics is both older and more advanced than that in Great Britain, and is conducted largely in the agricultural and forest *Reichanstalts.* It is intimately related both to agricultural and public health economy.

Practical Applications

Quite apart from the fundamental aspect of animal population research for the advancement of biological knowledge, the work has practical applications of the highest value to agriculture, fisheries and public health. Plagues of insects and mammals (especially voles and mouse-like rodents) are familiar to agriculturists all the world over. Even in normal years, these enemies levy heavy toll on our granary. Periodically, when the enemy population increases alarmingly, a famine might, and indeed does, result in many cases. The amount of grain carried away annually by mice and moles to the burrows runs into hundreds of maunds. Poor people in Bihar, and perhaps elsewhere, dig out and eat this grain. This habit formed the subject of a discussion at an All-India entomological meeting at Pusa some 20 years ago. The point under consideration was how to control field-rats. One of the methods recommended was the broadcasting of poisoned grain in the burrows, to which a member objected on the ground that in Bihar much of the burrow-grain is consumed by the poor who might thus be poisoned.

How vital animal fluctuations can be in the life of a nation may be judged from what happened in Germany in the last war. In 1917-18 Germany was hard pressed for food owing to Allied blockade. At this critical moment a great vole and mice plague overran the country, devouring food which should have gone into human stomachs. Referring to this plague Elton (*op. cit.*, p. 50) remarked: "And one can hardly doubt that the great destruction of food by voles and mice had an appreciable influence on the War's decision".

Fishery catches, especially in the sea, fluctuate from year to year and this has been attributed, in part, to natural periodic rythms in fish populations, and also in those of the plankton on which the fish feed. If we knew more about such rythms, and the causes that govern them, we could arrive at more scientific and rational methods of the production of

a food which, as a supplement to agricultural products, must play in India an ever-increasing role in the years to come.

A practical aspect of population research, which does not happen to be of outstanding importance to India but is of vital importance to Canada, may be mentioned in passing, because it has been the subject of intensive research for the last fifteen years and illustrates the applied side of population research very clearly. From the old archives of a number of commercial companies dealing in fur, Elton was able to show the existence of wild-life cycles in a number of fur-bearing animals, *e.g.*, red fox, voles and martens. In the red fox four-year cycles of abundance were established. The existence of these cycles has an intimate bearing on the fur trade since a year of low population is a precursor to a year of lean trade. It is the realization of this practical relationship between wild-life cycles and trade which must have induced a hard-headed business concern like the Hudson's Bay Company not merely to open its confidential archives to inspection by the zoologist (Elton) but also to partly finance this piece of research.

Finally, let us briefly examine the public health importance of population study, especially of rodents and insectivores. Mammals of these two orders include rats, mice, voles, moles and shrews. The close relationship between rats and bubonic plague is too well-known to need elaboration. An increase in rat population in towns is of intimate concern to public health, and although there is some rough indication of short population rythms in these rodents in India, much more remains to be done to understand these fluctuations species by species and to ascertain their causes. Russian zoologists have already recognized the importance of this aspect of disease and some large scale work is being carried on in the U.S.S.R. on the fluctuation of mouse-like rodents associated with bubonic plague. Similar fluctuations occur in the mouse-like rodents which carry plague in South Africa and Rift Valley fever of man and sheep in East Africa. Oriental typhus (also called Japanese river valley fever or tsutsugamushi fever), the cause of which is a virus, is carried by harvest mites to man from a reservoir which is believed to be the vole *Microtus montebelloi*. Similarly, the endemic typhus of the Indian hills around Kasauli (Simla Hills, Punjab) is believed to be transmitted by rat-fleas with rats (*Rattus rattus* group) acting as reservoirs, as was shown some years ago in the Typhus Enquiry conducted under the Indian Research Fund Association. Needless to emphasize, the study of population fluctuation of those rodents which act as disease reservoirs—focal points, so to speak, from which the disease can be spread in all directions—is of the utmost importance to public health. At the present moment the work is of vital significance in the East Asia and Pacific theatres of war for, oriental typhus extends from Assam and Burma right up to New Guinea. Tularaemia is another disease which is transmitted by rodents (hares and rabbits) in Norway and by water-voles in the U.S.S.R., and considerable work is being done in the latter country to study fluctuations in their population.

Considering that mammals play such an important role in the transmission of so many diseases in India, it is surprising that the Indian Research Fund Association has associated with its research committees no mammologist to advise them.

Problems in India: a Central Research Institute Necessary

In the foregoing account I have briefly discussed the importance of population research for fundamental biological research and, even more so, for applied biological research on problems intimately connected with agriculture and public health, not to speak of other side issues. The next question is where and by whom should such research be carried out. Perhaps the only published piece of population research so far carried out in India on a planned scale and sustained for a number of years was the work on the Desert Locust financed from 1931-39 by the Imperial Council of Agriculture Research.* I had the good fortune to take part in it from its very inception, and it left me with a healthy respect for the complexity of the issues involved in the study of population problems in general. For, it must be remembered that though details of technique and procedures would vary from class to class and even perhaps species to species, the fundamental problems of population are the same for all classes of animals. This experience, as well as a close study of the published work of others, enables me to lay down the following general principles of population study. Firstly, the study has to be carried out by a team of workers. A single individual, however brilliantly endowed, cannot achieve much unaided. Secondly, there must be a central organisation which should serve as a transmitting centre for questions (on information wanted) and a receiving centre for all incoming information as regards the population of the animal species under enquiry or its close allies. Thirdly, the work, to be at all fruitful and reliable, must be continued over a long term of years. Short term work carried out for 2 or 3 years is not of much use. Let me quote Elton (*op. cit.*, p. 207) with whose remarks my own experience entirely coincides: "All popula-

* The same body started, in 1940, a scheme for the study of insect populations in general, which, I think, is still in operation. The results have not yet been published.

tion research is tedious, and requires a five or ten year run if new techniques are to be evolved that will produce safe results. The work should be done in years of moderate abundance, neither slump nor final peak. For great scarcity would prevent any work at all, while peak years might introduce the complication of sudden mortality. Here the forecasting of the cycle assumes importance once more. . . ." And fourthly and finally, there must be no wild theorisation or reckless formulation of all-embracing laws. For, experience of population work shows that such laws (*e.g.*, the correlation of plague periodicities with sun-spot cycle, and so on), however attractive they might appear at first, have not generally led to a sound understanding of the causes of population flux. We must, therefore, follow the more fruitful but tedious method of tracking individual characters and factors in the hope of thus building up, step by step, an edifice which will give us a deeper insight into population flux. At the same time we must not forget that a certain amount of theorisation or postulation of working hypotheses is essential, for without them no progressive biological research is possible. In India what we need most to start with is a patient collection of facts and still more facts. Compared to the imposing array of records of animal populations figures in Europe and America, on which the ideas of wild-life cycles in those countries are based, India is almost a perfect blank.

And now the final question: Who can do this work? As I have said above, team-work is essential. For studies on insects, excellently equipped institutions exist at the Centre as well in the Provinces, so that what remains neglected is the study of vertebrate populations, especially of birds, mammals and fish. For the study of this problem there should be established forthwith a *Central Institute of Animal Population and Migration** staffed by competent zoologists. The main function of the Institute would be the study of vertebrate populations and migrations (particularly of birds and mammals and fish, though other groups may also be studied) from all angles. It will do both fundamental and applied work. Besides a staff of zoologists, one mathematician (pure) and one statistician would be a great asset, for a good deal of population work involves some mathematical knowledge which is not found in the equipment of an average biologist. Let us hope that in the great scheme of reconstruction in India, this Institute will find a worthy place.†

* Several years ago, in my Indian Museum lecture on *Migration of Birds* (SCIENCE AND CULTURE, 5, 669-678, 1940), I had pleaded for the establishment of Bird Migration Observatories in India. These Observatories should form an important part of the Central Institute now visualised.

† I am greatly obliged to Dr B. N. Chopra (Benares) and Prof. K. N. Bahl (Lucknow) for many friendly suggestions in connection with this article.

DISEASES OF RICE AND METHODS FOR THEIR CONTROL

J. C. SAHA

BOTANY DEPARTMENT, PRESIDENCY COLLEGE, CALCUTTA

INTRODUCTION

THAT rice occupies an important position in the economic structure of India, where it is the staple food of the majority of her huge population, needs no emphasis. Although India is the biggest producer of rice in the world having an annual out-put of about 35,000,000 tons, China and Japan coming second and third in the list with 30,000,000 and 10,600,000 tons respectively, her requirement is greater than her production with the result that she has to import annually an enormous quantity from outside. And what becomes the situation once this outside supply is impaired with has been bitterly demonstrated in these few years since the enemy occupation of Burma, which so long used to be the normal source of this outside supply. Two courses are open to improve India's rice supply position: (1) to put more land under rice cultivation, and this cannot be done without drawing upon the acreage of other crops, which are equally important for a balanced supply of other economic as well as food crops; (2) to improve out-turn per acre by the use of improved seeds, improved methods of cultivation, application of artificial fertilizers, etc. But the release of more land or the improvement in the methods of cultivation, etc., will not in itself solve the problem unless we can protect and conserve the crop we grow from damages and depredations caused by the visitations of fungal diseases and insect pests. How often the happy

prospect of a bumper crop has ultimately been ruined by the sudden outbreak of a disease in an epidemic form. So, along with other measures of improvement, measures for preventing, restricting and controlling losses caused by diseases and pests should proceed to lead us to our desired goal.

It may be mentioned here that the present position of our knowledge regarding the various diseases of rice is not altogether complete. Except a few diseases that have been more fully studied, information on many aspects are still lacking about a number of diseases while there are still others regarding which investigations have not proceeded beyond the preliminary stage. And whatever knowledge we possess at present is spread over the pages of different journals, periodicals, etc., that are not readily available at hand. The present endeavour is therefore an attempt to bring together, and make it available over the compass of a few pages, all the main information regarding the various diseases that attack the rice crop, the extent of damage they cause and the measures that are practised to prevent or control their damages in various rice growing countries of the world. In the following pages the cultivator will find information how to protect his crop against diseases while a contemplating investigator will have an idea of how much work has already been done, of the gaps in our knowledge that remains to be bridged over so that he may accordingly shape his line of investigations.

In the descriptive section, the diseases that are definitely known to occur in India have been marked with asterisk.

DIAGNOSTIC KEY TO DISEASES

Disease primarily manifest in the grain or ear	
* Ovaries destroyed	
(*a*) Ovary transformed into a green velvety body measuring about twice the size of a normal grain	False Smut.
(*b*) Ovary replaced by a mass of black spores, which remain for sometime enclosed by the ovarian wall	Bunt or Black Smut.
* Ovaries not destroyed	
(*a*) Kernels coloured yellow	Yellow Kernel Disease.
(*b*) Kernels coloured black	Black Kernel Disease.
(*c*) Inflorescence attacked and destroyed	Udbata Disease.
Disease not primarily manifest in the grain or ear	
† Tillering excessive	
(*a*) Black sclerotia on or within the stubbles accompanied often by the sterility of the grains	Sclerotial Disease.
(*b*) Chlorotic streaks on leaves, plants stunted	Stunt or Dwarf Disease.
(*c*) Leaves twisted, covered with white downy growth	Downy Mildew.
† Tillering not excessive	
Tillering subnormal	
(*a*) Brown discolouration of the sheath of the crown- and lower-leaves ...	Ophiobolus Disease.
Tillering abnormal	
(*a*) Abnormal elongation of infected tillers; development of adventitious roots from the 1st, 2nd, 3rd nodes above the soil, infected at the collar region, and when pulled easily separates at the collar ...	Fusarium Disease.
Tillering normal	
Roots not normal	
(*a*) Roots of one kind only, *viz.*, long, thick, coarse roots devoid of branches and root hairs; premature drying up of lower leaves ...	"Pan-Sukh" Disease.
(*b*) Roots as in "Pan-Sukh"; head erect, neither bends nor droops, often completely sterile	Straight Head Disease.
(*c*) Roots rot away, followed by the death of the plant ...	Root Rot Disease.
Roots normal	
Leaf sheath primarily attacked	
(*a*) Spots dark brown, irregular	Phyllosticta Disease.
(*b*) Spots reddish brown at first, the centre turning lighter later on	Sheath Spot Disease.
Leaf sheath not primarily attacked	
Spots not linear	
(*a*) Greyish black to black spots or streaks on leaves ...	Leaf Smut.
(*b*) White chlorotic, elongated streaks or areas at the tip or upper part of the leaves	White Tip Disease.
(*c*) Spots pale brown with ashy grey centres	Blast Disease.
(*d*) Spots having greyish-green, bluish-green or straw-coloured centres with distinct brown borders	Rhizoctonia Disease.
(*e*) Spots reddish brown with narrow yellow margin, much smaller and round when young, become larger or form patches or streaks on leaves, sheaths or stems ...	Helminthosporium Disease.
(*f*) Spots not formed but all plants over an area become stunted, turn yellow and wither away	"Myitpo" Disease.
Spots much linear	
(*a*) Spots brown in colour	Cercospora Leaf Spot.

DESCRIPTION OF DISEASES

False Smut*

Cause: *Ustilaginoidea virens* (Cke.) Tak.*

This fungus attacks the ear and develops its fructifications in the ovary of individual grains. As a result they are transformed into nearly round velvety green masses measuring more or less twice the diameter of the normal grain. These sclerotial bodies, composed of pseudoparenchymatous structure especially at the centre, are olive green externally, nearly white at the centre and orange-yellow below the surface. The olive green colour of the sclerotium is due to the production of spores of the same colour over its surface. The olive green dusts that stick to our fingers on touching a sclerotium are nothing but these spores. The number of grains infected in each ear vary widely depending on the intensity of the attack. Usually a limited number of grains in an ear are infected and these may occupy any position on the ear. The sclerotial bodies grown out of the ovary of individual grains, burst out above and laterally between the glumes. The glumes remain unaltered and more closely applied to the centre of the lower part of the fructification. Cases are also found when one or the other of the glumes becomes burried partly or entirely within the tissues of the developing sclerotium.



Fig. 1. False Smut Disease

Occurrence.—In India the disease is often seen in Bengal, Bihar, Orissa, some parts of Madras, Western Malabar and in Tinnevally. Outside India the disease is widely known in eastern Asia and Louisiana (U.S.A.).

Control Measures.—The complete life history of the fungus is not known, nor its mode of infection, etc. All attempts to reproduce the disease through contaminated seeds or dusting the ear with spores at the time of flowering have proved a failure. At the same time it is known that the fungus cannot winter over in the field for more than a few months.

"In the absence of knowledge of the full life-history of the parasite" (Butler, 1913), it does not become possible to recommend proper remedial measures. Fortunately the disease does not appear in any severe form in any rice growing tract of India; and when appears 3 to 6 grains in an ear are affected, and the number of such infected ears in a field is also limited. The loss due to this disease comprises not so much in the reduction in yield as to the presence of black fragments of the sclerotium in the finished products the presence of which reduce the market price.

Bunt or Black Smut*

Cause: *Tilletia horrida* Tak.

The parasite attacks the individual grains of an ear. The fungus is said to enter into the germinating grains while still underneath the ground and lives within the tissues of the developing plant, becoming evident at the time of the grain formation. The pathogen now reaches the grain and forms elliptical, opaque mass of black spores, which remain enclosed within the thin outer skin (membrane) of the grain. As the spore-mass, thus developed, remain enclosed by the uninfected glumes, it is usually difficult to detect out the infected grains. But in other cases the infection becomes evident externally with the forcing apart a little of the glumes with the subsequent exposure of the mass of spores, which now remain sticking to the glumes of the infected or healthy adjacent grains. Depending on the intensity of attack the sporemass may entirely replace the kernel or may form only a layer inside the endosperm.

Though nothing is definitely known, it seems probable that the attack spreads with the infection of new flowers by spores from the diseased grains; the seed produced from such smutted flowers will in its turn produce plants having a number of grains again smutted and thus the cycle goes on.

Occurrence.—This disease is wide-spread in its distribution, occurring throughout the rice growing areas in Burma, China, Siam, Java, Indo-China and in parts of the United States. The disease was first reported from Japan from where it is said to have spread out. In India it has been reported from various tracts but no where in this country the loss has been severe.

Control Measures.—This parasite of rice can be controlled by the 'hot-water treatment' or by the application of the fungicides to the seeds. Experiments in South Carolina have proved that for prevention purposes the following procedure is very helpful: Put the grains in cold water and then reject the light grains that remain floating on the surface. These light grains include the infected and diseased ones. Then soak the remainder for 24 hours in a solution of 1½ lb. liver of sulphur in 25 gallons of water, or by soaking the grains for 2 hours in a 2 per cent solution of the same. This method remains to be tried in India.

Sclerotial Disease*

Cause: *Sclerotium oryzae* Catt.

Though a good number of publications have appeared on this subject from many rice-growing countries, the opinions still highly differ about the symptoms and the extent of damage due to the attack of this disease.

Cattaneo (1879), the first discoverer of this malady observed black discolouration of the culm near the soil level later spreading to leaf sheath, the tearing of the epidermis, culminating in the withering and death of the plant. His observations were confirmed by Briosi and Cavara (1886). But Butler (1913) associated excessive tillering, sterility and basal discolouration of the stem with the pathogen; while Shaw (1913) closely afterwards held that "infected plants can usually be distinguished from their healthy neighbours by the phenomenon of 'tillering' The infected culm gradually turns yellow and dies; any grain which it bears is light and poorly developed. . . . If a diseased culm is split longitudinally the basal portion is found to be infected with the fungus , and small black sclerotia can be seen dotted all over the inner surface."

The recent publications bearing on this subject are those by Mundkur (1935), and Luthra and Sattar (1936). Mundkur could not correlate sterility or excessive tillering nor could produce such or other symptoms, said to be associated with this disease, in plants grown "in pots or fields heavily infected with sclerotia" though in test tube experiments the fungus was able to cause the disease. He, however, was able to find considerable sclerotia on rice stubbles. Luthra and Sattar, on the other hand, associate one or the other of the following symptoms with this pathogen, *viz.*:—(1) Stem-rot—2 to 3 basal leaves including their sheaths wither and dry up, turn dark and begin to rot. On nodes under such sheaths small darkish spots appear and the infection spreads up and sometimes down. The infected region begins to rot and becomes so soft that it collapses and the plant falls over and dies, but if remains green the ears fail to produce any grain (*i.e.* sterility). (2) Discolouration of the bases of stems—here though no rotting of stem is visible, bases of culms appear discoloured with the production of sclerotia. (3) Drying of basal leaves—none of the above symptoms are found but some leaf-sheaths and leaf-blades get dried up on account of the disease. Sclerotia are visible on such leaves and sheaths. And (4) the presence of sclerotia on stubbles without any damage.

The disease in one or more of its symptoms, is widely distributed in India and Burma, and has also been reported from many countries *viz.*, Ceylon, Indo-China, Japan, the Philippines, Italy, Arkansas, Louisiana and Texas.

The extent of the damage due to this disease particularly with reference to India has been variously estimated by various investigators. Butler (1913) holds that "there is little evidence available that the disease occurs on a large enough scale in India to make treatment profitable". Shaw (1913) says that "it is the loss of grain which constitutes the most serious damage by this fungus". But, Mundkur (1935) claims that "under normal Indian conditions these fungi are unable to produce disease in the rice crop". While Luthra and Sattar (1936) estimate the damage to vary from 5 to as high as 80 per cent in some places.

Occurrence.—The disease is reported in one or the other of its symptoms from almost all rice growing countries of the world.

Control Measures.—Nothing is definitely known about the control practices that will help to keep down the losses. As sclerotia perinate in the soil rotation should be practised. Hand-picking of diseased plants and burning them out have also been suggested. Proper irrigation is said to keep down the damage.

Helminthosporium Disease*

Cause: *Helminthosporium orzae* Miy. & Hori.

The symptoms appear first on the leaves spreading soon to other aerial parts of the plant. Small brown spots measuring 1—10 mm. × 0·5—4·0 mm. appear on both surfaces of the leaves, leaf sheaths and later on glumes. These spots may increase in size, darken in the middle with a fine yellow margin and may merge together so that large brown areas become visible. As a result the leaves wither and dry up, presenting an yellowish appearance. In severe cases of leaf attack or glume attack the paddy grains do not develop properly and become shrivelled up and discoloured. Later in the season the basal nodes of the rachis are attached and the affected re-

gion appears velvety, darkened, and the ear becomes curved rather widely.

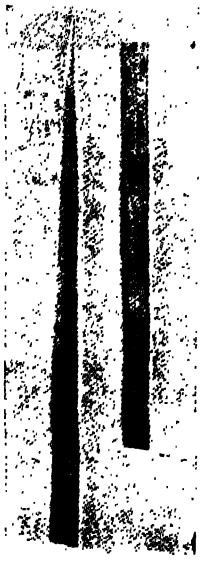


FIG. 2. Helminthosporium Disease

The disease is sometimes known as the stripe disease.

If the disease appears very early when the seedlings are only a couple of inches tall, a considerable portion of them die away while the surviving ones become weak. The struggling plants often remain sterile.

The atmospheric conditions that predispose rice to the attack by this malady are: (1) cloudy and foggy weather, (2) heavy and continued showers for a period of days together.

Occurrence.—The disease is wide spread in its distribution being found in India, Burma, Ceylon, Indo-China, Japan, the Philippines, and Italy, and as saprophytes on rice in Louisiana and China.

Control Measures.—The fungus lives from season to season through spores remaining in the soil or on diseased grains and plant parts. Further it is also known that a number of grasses and weeds near about the paddy field as well as the volunteer paddy plants that grow in the same field after paddy is harvested act as the alternate host plants during the period between the harvest and next year's sowing. But it still remains to be determined if all or any one of the above acts as the principal source from which the infection starts next year.

The control measures that are recommended and practised in one country or the other may be enumerated as follows: (1) Rotation of crops; (2) Seed dressings by steeping the seed grains in 2 per cent solution of blue vitrol for 10 minutes as practised in U. S. A., or by soaking the grains in ordinary water for 8-12 hours and then treating the seeds in hot-water maintained at 50°—52°C for 10 minutes. Seed treatment with 2 per cent mercuric chloride solution is also practised in some countries, (3) Spraying of infected seed-beds or fields with Bordeaux mixture.

It may be mentioned here that the loss due to this disease has assumed a serious proportion in recent years. It broke out in such a severe epidemic form over Bengal, especially in northern and western districts in the year 1942 that it contributed a share in the Bengal food famine of 1943.

"PAN-SUKH" DISEASE*

Cause: *Physiological*

The first sign of the disease, as the vernacular name signifies, is the drying up of the outer leaves of the plant. Further, the root system of an affected plant is abnormal in that while the normal plant bears two kinds of roots—(*i*) long, thick, coarse roots (*i.e.* water roots), and (*ii*) a thick mat of fine, entangled secondary roots firmly adhering to the soil particles, those of the diseased plants are of one kind only, *viz.*, long coarse roots (*i.e.* water roots) which are very rarely branched, devoid of root hairs and dead or dying at the tips.

The effect of the disease on the life-cycle of the plant is variable depending on the age of the plant. If the attack breaks early when they are very young the plant produces few tillers, few leaves and scarcely develops any head; if later on in the season, depending on the time, the head may come out a little, half in length or almost fully but in any case the grains are not filled though the glumes remain normal in shape, form and colour. If however, the attack breaks out late when the plants are fully grown and the grains almost filled up, the only symptom is the premature drying of the outer leaves.

The diseased plants, though greatly reduced in vigour, do not altogether die because such affected plants produce a few new adventitious roots from the upper submerged nodes; and these new roots are sufficient just to keep the plant alive but not enough to meet the increasing demand of either a vigorous vegetative growth or that during ear emergence.

It may be mentioned here that the disease outbreaks when water stands continuously for a long time at the earlier stages of the growth of the plant. In many cases the diseased field becomes conspicuous by the presence of a few green leaves in a mass of dead brown leaves.

Occurrence.—So far known at present, the disease is limited in its distribution in certain regions of the Central Provinces; and it s quite likely that further

searches might show its presence in other parts of the country as well.

Control Measures.—The disease can be effectively controlled and the plants put forth again to a vigorous and normal growth if the water in the field is drained off as soon as the symptoms begin to appear. If the disease appear late in the season when the plants are heading water cannot be drained off without impairing the grain formation, the application then of 30 to 50 lbs. of ammonium sulphate per acre stops not only the further progress of the disease but also helps the plants to head normally.

Straight-head Disease*

Cause: *Physiological*

As the name suggests the chief symptom of the disease is that the heads (*i.e.* panicles) are nearly sterile and stand erect in contrast to the normal heads that are drooping. Other characters which also help in the diagnosis of the disease before or after heading are: the leaves are greener, stiffer and stand more erect than the normal ones; the sheaths adhere more closely and firmly to the culm; diseased plants remain green longer than the normal plants and the root system of such a plant is abnormal in that while large, coarser roots (*i.e.* water roots) are produced amply and branched sparingly as compared with the normal plants, the thick mat of fine, entwined secondary roots are very limitedly produced. Depending on the intensity of the disease, the head may come out almost completely, partly or not at all; the glumes or other parts of the inflorescence are aborted, distorted or perfect, but the flowers still remain sterile and therefore no kernels are formed.

Though opinion is at one that improper soil aeration is the cause of the disease, different workers suggest different explanations of how this deficit of oxygen in the soil is brought about.

Occurrence.—The disease is known from India, Burma, the Philippines and Bulgaria but it is only in the southern states of U.S.A. that the disease assumes destructive form among the irrigated rice.

Control Measures.—The straight-head disease can effectively be prevented if the fields are irrigated for a period of 5-6 weeks beginning from the time the plants are 10-12 days old. If the disease appear at this time the field may be drained out and left half dry for 2 to 3 weeks. When the plants appear withering and yellowish, water may again be allowed to enter and stand there for the rest of the season.

Stunt or Dwarf Disease

Cause: *Virus*

The disease, as the name implies, is characterised by the general stunting of the plant accompanied by excessive tillering and dark green colouration of the leaves. The characteristic chlorotic areas appear before the leaves unroll; these areas elongate and extend along the leaf parallel to the veins and the midrib forming fine, continuous streaks, varying from minute dots to several millimeters in length and 0·1 to 1 mm. in breadth. The chlorotic areas appear white in transmitted light. The infection becomes very severe when younger plants are attacked, they become very badly stunted and produce, if any, a limited number of dwarf sterile panicles.

The disease does not spread through soil, seed, leaf mutilation or by juice injection but through the eggs of a specific insect vestor, *viz.*, *Nephotettix apicalis* var. *cincticeps*.

Occurrence.—This disease appears in severe form in western Japan.

Control Measures.—The control measures consist in the elimination of the specific insects through insecticidal sprays and the eradication and burning out of any plant that may show any symptoms of virus infection.

Leaf Smut*

Cause: *Entyloma oryzae* Syd.

The disease appears at the flowering time and attacks the leaves forming greyish-black streaks thereon. In severe cases the attack extends on to the stem. These spots (sori) contain the black spores of the fungus. As a result of such destruction of the green tissues, the photosynthetic activity is greatly hindered in consequence of which the grains on the ear, though not attacked, fail to fill normally and necessarily there is a great reduction in yield. The disease is sporadic in its appearance becoming epidemic once in three or four years.

Occurrence.—The disease has been reported from Bihar, Orissa, Poona, Lower Burma, Japan, and Arkansas, Louisiana and Texas in the United States.

Udbatta Disease*

Cause: *Ephelis oryzae* Syd.

The fungus was first noted in Coimbatore in 1913 and was identified later to be *Ephelis oryzae*. The disease appears at the flowering time and attacks the inflorescence, which later on becomes completely destroyed.

Occurrence.—This disease has been recorded in Madras, Poona, Bombay and the Central Provinces.

Control Measures.—Nothing much is known about the disease so as to suggest any helpful control measure. Further researches on this subject are required.

Ophiobolus Disease

Cause: *Ophiobolus oryzinus* Sacc.

Ophiobolus oryzinus attacks rice plants in seedling or heading stage depending sometimes on the host variety. The plants are not generally killed outright but greatly injured as a result of retarded photosynthetic activity due to the killing of the green tissues of the leaves. The disease is further characterised by a brown discolouration of the sheaths of the crown leaves of the plant progressing later to those leaves situated much below. On the inner surface of such sheaths dark reddish brown mycelial mats are seen and there develop in the discoloured tissue considerable perithecia. The culms are also infected but do not bear perithecia. Infected plants scarcely produce any tiller, and frequently not more than a single head in a clump is produced.

Occurrence.—This disease has been reported from the Philippines, Japan and Arkansas and Stuttgart in Ark (U.S.A) and Colombo.

Control Measures.—Nothing is known about its control measures.

Phyllosticta Disease

Cause: *Phyllosticta oryzae* Cook. et. Mass.

The fungus attacks the leaf sheath forming irregular dark brown patches whose centres become lighter as they enlarge, destroying the sheath and thereby injuring the leaf blade. But in the Philippines the fungus forms small spots on the leaves. Sometimes the attack is so serious as to cause the leaves to turn pale and die. As a result of such an attack the grains within the glumes turn brown and become worthless; and when the glumes are themselves infected no grains are formed or if already formed as in the cases when the glumes are attacked later, the grains become spotted and valueless.

Occurrence.—The disease has been reported from Japan, Ceylon, China, Formosa and the Philippines, Arkansas, Louisiana and Texas.

Control Measures.—No precise work has been done on the aspect of controlling the diseases. Fortunately the disease has never been severe.

Rhizoctonia Disease*

Cause: *Rhizoctonia sp.*

The disease attacks stems, leaves and outer leaf sheaths of seedling and mature rice plants and in the long run is the cause of serious losses. The spots on the leaves and sheaths have greyish-green, bluish-green or straw-coloured centres with distinct brown borders. The spots, which remain very distinct even after the death of the infected plant, are usually elliptical to oblong when young but become large and irregular by coalescence later. In severe attacks most of the outer leaves die and fall off and the parts of the plant above the region of attack turn yellow. Dwarfing and complete sterility of the panicles may result from the attack of this fungus. During moist weather minute drops of yellowish brown liquid are seen collected on the surface of the lesions. On the surface of the diseased tissues are seen growing brownish, silky mycelium, which later produces sclerotia. Sclerotia are at first white, then finally brown, and at maturity fall to the ground. The infection may arise from the fungus hibernating in the soil or from contact with a similarly diseased plant.

Occurrence.—The disease has been reported from the Philippines, and also from the following countries where the extent of the damage by this pathogen is not particularly known, namely, India, Ceylon, Japan and the United States.

Control Measures.—As the pathogen perinates in the soil the latter should be sterilized by heating. This is practicable and very useful in small plantings as in seed-beds. In badly infected fields the dead and diseased plant materials should be collected and burnt. After a heavy rain the land should be ploughed to bury the sclerotia (which are then killed within 5 months), harrowed and rolled. If the field can be flooded and kept under water for a period of three months the fungus is easily exterminated. Rotation of crop is not helpful but thin planting has a beneficial effect.

Sheath Spot Disease

Cause: *Trichoderma lignorum* (Tode) Harz.

This new sheath spot disease of rice has recently been described from the United States causing considerable damage to the crop in Texas, Louisiana and Arkansas. The fungus attacks the leaf sheaths, and invasion of the culms is very rare. The lesions become first visible on the sheaths at about the water line during the middle part of July as reddish-brown ("light seal brown" according to Ridgway) spots and measure 2—3 mm. by 1 mm. Soon afterward they enlarge considerably becoming as large as 10 mm.; the centres of these spots now turn lighter in colour ("cream" according to Ridgway).

Sometimes the central portion of the spot is irregular in outline due to the very slow bleaching of the tissues over the vascular strands. Occasionally a definite strip extending from the base to the tip of the leaf may develop apparently in continuation of the sheath infection. Such spots whether on the sheath alone or on both the blade and the sheath, cause ultimately the death of most of the leaves as a,

result of which the plants die or if survive fail to produce healthy ears.

Control Measures.—No work has yet been done on aspects of controlling the disease.

Root-Rot Disease*

Cause: *Undetermined*

The root-rot (also known as 'mentek') disease attacks the root system of seedlings or young plants especially those growing on alluvial fields. Early stagnation of water or heavy and continued rains are said to be the favourable conditions for the spread of the disease.

Occurrence.—The disease has been reported from Bengal, Japan, the Philippines, Java and Dutch East Indies. In the latter country the disease causes great damage.

Control Measures.—Application to the soil of double supersulphate minimises the extent of the damage.

Fusarium Disease*

Cause: *Fusarium* sp.

This disease may appear in the seedling stage or later. When seedlings are attacked they turn pale or yellowish-green and die, whether transplanted or not. In older plants the disease is characterised by the abnormal elongation of the infected tillers which come into 'spot blade' several weeks before the rest of the healthy crop; they bear pale green boot leaves and shoot conspicuously above the general level of the crop. The culms of such plants come out of their sheaths, revealing the basal regions of the internodes. These plants are particularly attacked at the collar region and succumb within a week; when pulled up the dead plants easily separate at the collar. The leaves are characterised by turning brown at the margin and remaining green longer in a strip on both sides along the midrib, the leaves ultimately drying up one after another from below. The culm also produces adventitious roots from the first, second and the third node above the soil but the under ground root system remains normal. The diseased plant on splitting shows a distinct discolouration of the spongy tissues near the node. The fungus is sometimes said to cause sterility in plants.

In Japan the fungus causes more or less the same symptoms in the seedlings where its effect is commonly known as 'bakanae' but the adventitious roots are not produced nor the other symptoms on the mature plants are seen.

Occurrence.—The disease is reported from Manipur, Gourdaspur, Pusa and Madras in India, from Japan, China, Ceylon, United States, the Philippines, British Guiana, Madagascar, Indo-China and other countries.

Control Measures.—The disease can be controlled to some extent by half an hour's treatment of the seed with 2% copper sulphate solution before sowing.

(To be concluded)

THE FAMINE AND DISINTEGRATION OF EDUCATION IN RURAL BENGAL

K. P. CHATTOPADHYAY and RAMKRISHNA MUKHERJEA

Introduction

EDUCATION in Bengal has suffered a serious set back since 1943 on account of the famine and its aftermath, the epidemic. In the following note an attempt has been made to determine the degree of disintegration of general education (primary, middle and high standard) in Rural Bengal as well as its causes. The discussion is based on the material collected in the course of a sample survey carried out along with the Bengal Rehabilitation enquiry conducted by one of the writers (Prof. K. P. Chattopadhyay) in collaboration with the Indian Statistical Institute in the latter part of 1944.

Sampling Procedure

In 1943-44 the intensity of the famine and epidemic differed markedly in different parts of Bengal. Therefore an attempt has been made to group the different areas in a few homogeneous classes based on the intensity of affection in 1943. The basis of grouping followed in the enquiry has been the classification adopted by the Revenue Department, Government of Bengal.[1] In that classification (Appendix 1) 12 subdivisions were placed

[1] A scheme for Relief and Rehabilitation in Bengal (Revenue Department) Government of Bengal, 1944.

in class I as most severely affected, 13 in class II(a) as moderately affected, 12 in class II(b) as also moderately affected but less than the preceding class and 6 in class III as slightly affected. The remaining 43 subdivisions (which may be grouped in class IV) were stated to have been very slightly affected or not at all. A list of the subdivisions studied is given in appendix 2. We studied all the 12 subdivisions in class I, 9 in class II(a), all the 12 in class II(b), 4 in class III and 3 in class IV. In each of the selected subdivision a number of villages were taken up at random, and the number of students (boys and girls) in each village in the year 1939-40, and the middle two quarters (July-December) of 1943-44 and 1944-45 was recorded by personal enquiry.

Nature of Material

Table 1 gives the number of subdivisions, villages, and total number of students studied in each group. It indicates that the samples taken were fairly large and so should give a reliable estimate of the disintegration of education in Rural Bengal.

TABLE 1

TOTAL NUMBER OF SUBDIVISIONS, VILLAGES AND POPULATION IN EACH CLASS AND THE NUMBER OF SUBDIVISIONS, VILLAGES AND STUDENTS IN THE VILLAGES SURVEYED BY CLASS OF AFFECTION

Classification	Sub-divisions		Villages			Number of students in the villages surveyed		
	Total	Surveyed	Total (in lakhs)	Surveyed (actual)	Rural population in 1943 (in lakhs)	1939	1943	1944
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Class I ..	12	12	0·12	117	117·1	13419	8,367	7,952
,, II (a) ..	13	9	0·18	71	117·7	6,895	4,123	4,349
,, II (b) ..	12	12	0·11	92	65·3	5,481	4,150	3,883
,, III ..	6	4	0·06	21	40·5	1,787	1,400	1,185
,, IV ..	43	3	0·37	9	211·2	421	486	480
Rural Bengal	86	40	0·84	310	551·8	28,003	18,526	17,849

The classification adopted by the Revenue Department has been proved by our analysis to be somewhat arbitrary. Tables 2 and 3 represent the cumulative frequency distribution of the villages surveyed by class of affection under the proportion of students in 1943 and 1944 in percentages of the number in 1939.

It will be noticed from cols. (7)—(11) of table 2, that column (7) which gives the percentage of students in area included under Class I reveals the worst conditions, compared to the other areas. The inclusion of the areas in Class I is therefore justified.

TABLE 2

CUMULATIVE FREQUENCY DISTRIBUTION OF VILLAGES BY CLASS OF AFFECTION UNDER THE PROPORTION OF STUDENTS IN 1943 TO 1939 AS PERCENTAGE

Percentage of students in 1943 to 1939	Cumulative frequency distribution of villages: Number surveyed					Percentage of total				
	Class I	Class II (a)	Class II (b)	Class III	Class IV	Class I	Class II (a)	Class II (b)	Class III	Class IV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Above 200			6		...	...	3			
,, 170	1	4	10		1	1	6	11	...	11
,, 140	3	12	17	1	1	3	17	19	5	11
,, 110	7	16	28	3	4	6	22	31	14	44
,, 90	15	18	38	6	4	13	25	42	28	44
,, 60	54	42	54	12	7	46	59	59	57	78
,, 30	83	67	73	18	8	71	94	80	86	89
,, 0	106	69	87	21	8	91	97	95	100	89
0 & above	117	71	92	21	9	100	100	100	100	100

But the figures for the remaining four columns (8)—(11) which are for the other four classes, arranged, allegedly in order of decreasing affection, do not show any such gradation. Any estimation of the degree of disintegration of education in each class of area has not therefore been attempted. Only the provincial estimates are given as statistically valid.

TABLE 3

CUMULATIVE FREQUENCY DISTRIBUTION OF VILLAGES BY CLASS OF AFFECTION UNDER THE PROPORTION OF STUDENTS IN 1944 TO 1939 AS PERCENTAGE

Percentage of students in 1944 to 1939	Cumulative frequency distribution of villages: Number surveyed					Percentage of total				
	Class I	Class II (a)	Class II (b)	Class III	Class IV	Class I	Class II (a)	Class II (b)	Class III	Class IV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Above 200	1	4	3	1	...	1	6	3	5	...
,, 170	3	10	6	2	1	3	14	7	10	11
,, 140	4	14	17	2	2	3	19	18	10	22
,, 110	10	18	28	6	4	9	25	30	29	44
,, 90	14	21	36	6	4	12	30	39	29	44
,, 60	44	30	50	8	6	38	42	54	38	67
,, 30	95	57	75	20	8	81	80	82	95	89
,, 0	109	68	87	21	8	93	96	95	100	89
0 & above	117	71	92	21	9	100	100	100	100	100

Extent of Disintegration

Table 4 indicates the extent of disintegration of education in Rural Bengal in 1943 and 1944.

TABLE 4[2]

Percentage distribution of villages in Rural Bengal in 1943 and 1944 under proportion of students in 1943 and 1944 shown as percentage of numbers in 1939

Percentage of students	Distribution of villages in percentage of total	
	1943	1944
(1)	(2)	(3)
Above 200	2	2
171 200 ...	6	8
141 – 170	4	7
111 140	18	15
91 110	4	3
61 90	31	19
31 60	21	32
1 30	7	7
0	7	7

It is obvious from cols. (2) and (3) of the table that though the proportion of students in 1943 and 1944 to the numbers in 1939 has a very wide range of distribution the variation is mostly towards deterioration and not towards improvement. We may take for the present the villages in which the number of students varied from 91-110 as "normal", that is, a layer which remained stationery. We shall see later that this concept requires modification. However, at this stage we may say definitely that in Rural Bengal the educational system had suffered severely in 66 and 65 percent respectively of the villages in 1943 and 1944. In 7 percent of the villages all education disappeared in 1943, and this condition persisted in 1944.

Mean Proportion of Disintegration

Table 5 gives the mean and standard error of the proportion of students in 1943 and 1944 as percentage of 1939 by class of affection and for Rural Bengal as a whole. As noted in a previous paragraph the figures for the different classes will not be separately discussed.

The provincial estimates shown at the bottom of cols. (2) and (3) indicate that 13% of the roll strength in 1939 was lost during 1939-43 and during 1943-44 another 4% followed suit. The further deterioration in 1943-44 as shown here is however not yet statistically significant.

TABLE 5[3]

Mean and standard error of ratios of students in 1943 and 1944 as percentage of 1939 by class of affection and for Rural Bengal

Classification	Mean ratio of students in percentage of 1939 with standard error	
	1943	1944
(1)	(2)	(3)
Class I	60 ± 5	57 ± 3
Class II (a)	77 ± 7	75 ± 8
Class II (b)	85 ± 13	74 ± 9
Class III	78 ± 2	72 ± 7
Class IV	112 ± 5	109 ± 4
Rural Bengal	87 ± 3	83 ± 3

Corrected Estimates of the Proportion of Disintegration

The numerical strength of students in Bengal did not remain the same year after year in normal times, but maintained a steady though slow progress. The annual figures published by the Government of Bengal in their Report on Public Instruction indicate that the rate of progress has also been increasing from year to year. This is in accord with the general impression, that in recent years at least the numerical strength of students has kept pace with and slightly surpassed the increase in number of children of school going age due to growth of population.[4] Therefore correct estimates of disintegration of education can only be obtained from the expected roll strengths on the basis of this rate of increase and the actual roll strength in 1943 and 1944. A study on the basis of proportions with respect to the numbers in 1939 will be definitely an underestimate.

[2] Weights used in calculating the provincial estimates of the extent of disintegration of education from the respective proportions in the different groups of affection are the total number of villages in each group according to the Census of 1941.

[3] Weights used in calculating the provincial estimates from the respective proportions in different groups of affection are the total rural population (calculated by deducting the urban from total population) in each group at the beginning of 1943, derived by interpolation from the Census reports of 1931 and 1941. Number of students, instead of population, should have been a better weight in any estimate of the students but as such figures by subdivision are not available in official reports, the population figures have been used as the next best, inasmuch as the increase in number of students will naturally have a positive correlation with the growth in population.

[4] According to the Reports on Public Instruction, Government of Bengal, the total number of students in high, middle and primary schools of Rural Bengal has increased from 2·11 millions to 3·19 millions, an increment of 51%, during 1930-31 to 1940-41; while during 1931-41, the total rural population has increased by 15% from 46·43 millions to 54·37 millions.

Table 6 gives the expected and the actual number of students in lakhs and the number of proportion of corrected estimates of loss of students in Rural Bengal in 1943 and 1944.

The great extent of disintegration revealed in table 6 is in agreement with the wide range of variations in the percentage of students seen in table 4 and the high standard errors of the mean proportions of students in 1943 and 1944 to the numbers in 1939, noted in table 5. High standard errors indicating a wide range of disintegration are also due to the fact that education in Rural Bengal is mainly restricted to the upper and middle layers of the population, as three fourths of the expenses on education have to be borne by the guardians of students and by the local authorities. Disintegration of education naturally depended principally on the socio-economic composition of the population in the villages and their power to fight the consequences of the famine. This varied largely in the different areas.

TABLE 6[3]

ESTIMATES OF EXPECTED AND ACTUAL NUMBER OF STUDENTS IN LAKHS IN RURAL BENGAL AND THE NUMBER AND PROPORTION OF (CORRECTED) ESTIMATED LOSS OF STUDENTS IN 1943 AND 1944

Year	Students (in lakhs) in Rural Bengal			Percentage of col. (4) to col. (2)
	expected	actual	loss	
(1)	(2)	(3)	(4)	(5)
1943	38·3	27·8	10·5	27
1944	29·6	26·5	3·1	11

Earlier we noted that the gross or uncorrected estimates of the loss in number of students in 1943 and 1944 came out as 13 and 4 per cent respectively, of the number at school in 1939. The corrected estimates reveal a much greater loss namely 27 and 11 per cent of the expected number on rolls.

[3] The expected number of students (col. 2) for 1943 has been calculated from the latest available official figure of 1940-41 at the rate of increase of 6·3% per year, the rate during 1939-40 to 1940-41. This rate might be an underestimate, since this is the probable rate for 1941-42, and in 1942-43 it could have been still higher. However, it is possible that, on account of evacuation and panic in 1941-42 due to the threat of invasion (the effect of which in Rural Bengal was probably very little), further progress was not effected and the rate of the previous year can be assumed to have been maintained if famine conditions had not intervened. Expected roll strength for 1944 has been derived from the estimated actual figures for 1943 at the rate of increase of 6·3% in the year. The old rate has been assumed since, if the disturbing factor had ceased to exist after 1943 and the normal condition had been restored, at least the 1940-41 rate of increment (if not a still higher one) must have come in.

In col. (3) the actual roll strengths in 1943 and 1944 have been estimated from the respective proportions of 1939 (that is, 87 and 83 per cents as shown in table 5). The figure of total number of students in 1939 has been obtained from the Report on Public Instruction, Government of Bengal, 1939-40.

CORRECTED ESTIMATES OF THE EXTENT OF DISINTEGRATION

Table 9 has been prepared to show the real extent of disintegration of education in Rural Bengal. Col. (1) of the table indicates the three landmarks to be considered to gauge the real extent of disintegration. The stationary layer in this column is different for 1943 and 1944 for obvious reasons. The roll strength in 1939-40 in Rural Bengal was 29·9 lakhs and the expected figure for 1943 was 38·3 lakhs, an increment of 28·1%. Hence the percentage which fell in the class interval 90-110 in 1939 should have shifted to this extent *i.e.*, to the class interval 120-40 approximately. It is the percentage in this interval found in 1943 which can be compared to that for the stationary layer for 1939. Again compared to the base year 1939 the expected figures for 1944 practically remain the same owing to the drop in 1943. Hence the class interval 90-110 has been considered as the actual stationary level for 1944.

TABLE 7

NUMBER AND PROPORTION OF VILLAGES BELOW, ABOVE AND WITHIN THE CORRECTED STATIONARY LEVEL OF ROLL STRENGTH OF STUDENTS IN 1943 (121—140) AND 1944 (61—80) IN RURAL BENGAL

Classification of level	Villages surveyed		Percentage total	
	1943	1944	1943	1944
(1)	(2)	(3)	(4)	(5)
Above stationary layer	34	89	12	32
Stationary layer ..	18	49	71	3
Below stationary layer	258	172	71	65

While the gross estimate noted earlier in para 5 of the extent of disintegration of education in Rural Bengal during the famine year gave the percentage as 66, (30% of villages having improved and 4% having remained in the stationary level) the corrected estimate gives 71% as its value (only 12% having improved and 17% having remained in the stationary level). Col. (5) of the table indicates the extent of further disintegration from 1943-44 to 1944-45. If the educational system had not disintegrated further during 1943-44 to 1944-45 the villages surveyed should have all been represented in or above the stationary layer, the layer being defined as noted in the foregoing paragraph. But column (5) shows that

in 65 per cent of the villages surveyed education has further disintegrated, that only in 32 per cent of the villages it has improved and that it has remained stationary in 3 per cent of the areas.

Cause of Disintegration

The surveyors who collected the statistics were also directed to ascertain from the villages and the school teachers the reasons for the drop in number of students in each case. Owing to the difficulty of collecting detailed and exact data on this point, only the main factors which could be checked were noted.

Table 8 records the main causes of disintegration of education in the villages surveyed.

TABLE 8[6]

Number and proportion of villages in which there was disintegration of education during 1943-44 and 1944-45, by the main cause of disintegration

Cause of disintegration of education during 1943-44 and 1944-45	Villages concerned	Percentage of total
(1)	(2)	(3)
Financial difficulty of students	85	37
Epidemic	43	19
Scarcity of cloth, kerosene and books ...	38	17
Students left studies to earn money ...	14	6
Death and emigration of students from famine, flood and epidemic	16	7
Abolition of schools ...	23	10
Scarcity of teachers ...	8	3
Any other cause	3	1
Total ...	230	100

Col. (2) shows that out of 310 villages surveyed decline in roll strength from 1939 to 1944 was observed in 230 villages. This is 74% of the total. Col. (3) shows that financial difficulty, the first effect of the food crisis in 1943, mainly accounts for the disintegration. Next in order are the epidemic and scarcity of cloth, kerosene, and books. It is noteworthy that in 6% of the villages surveyed students had to leave studies to earn their livelihood. This is reported mostly from the subdivisions worst affected by famine and epidemic of 1943-44, like the Sadar subdivision of Chittagong, and the Tangail and Kishoreganj subdivisions of Mymensingh, indicating the gravity of the situation in 1943-44. Abolition of schools and scarcity of teachers also account for the disintegration of education in a good number of villages. These two causes are practically the same, both being due to the economic crisis in 1943-44. Due to financial difficulties it was not possible to remunerate the teachers adequately and run the schools, and the teachers, also being unable to meet their requirements from their poor pay in those days of high prices, had to leave their profession for some better paid job (probably a war job) elsewhere. On the whole, table 8 proves the obvious fact that disintegration of education in Rural Bengal during 1943-44 and 1944-45 is closely linked up with and should be considered as one of the serious effects of the famine and epidemic during the period which completely upset the normal socio-economic balance of the people.

[6] In many villages disintegration of education was due to more than one factor, such as, financial difficulty of students and epidemic, etc. Such villages have been considered under the primary factor to make the table presentable and not unduly lengthy.

Conclusion

As stated in the Introduction an attempt has been made in this note to gauge the intensity and causes of disintegration of education in Rural Bengal in 1943-44 and 1944-45. It has been shown that not only the steady progress in the spread of education effected from year to year in normal times has been completely wiped out but deterioration has set in to an alarming extent. Table 6 has shown that 27% of the students in Rural Bengal has been lost in 1943. The loss in absolute figure is 10·5 lakhs. The table has also indicated that disintegration of education in 1943 was not a passing phenomenon, and that the situation had deteriorated still more in 1944, there having been a further loss of 3·1 lakhs of students in this period *i.e.*, 11% of the expected roll strength. Table 7, which indicates the extent of disintegration, has also confirmed this conclusion. Proper planning should, therefore be immediately taken up for educational rehabilitation of Bengal. Table 8 which gives the cause of disintegration has shown that it is mainly due to the economic collapse of Bengal in 1943-44. Any serious scheme for educational rehabilitation of Bengal must take this into account and include it along with the general socio-economic planning for rehabilitation in Bengal, of course, with due considerations of its special features.

The seriousness and urgency of the problem will be well realised from table 9 which gives the population of school going age (7-17 years) and number and proportion of students in Rural Bengal in 1930-31 and from 1939-40 to 1944-45.

The age group 7-16 has been selected for reasons stated in the notes at the end. It should be obvious that the relative value of the percentages in column will change only slightly if the age grade 6-15 had been selected. It will be noticed from col. (5) of the table that in 1930-31 only 20·6% of the population of school going age were in the primary, middle or

high schools in Rural Bengal. In 1939-40 the proportion was 24·5%. In 1940-41 also (the last normal period in regard to famine and epidemic for which official figures are available) the steady trend of increase was maintained. But in the last two years there has been a considerable set back and the educational level has receded to that prevailing twelve years earlier.

TABLE 9[7]

POPULATION OF SCHOOL GOING AGE (7 –17 YEARS) AND THE NUMBER AND PROPORTION OF STUDENTS IN RURAL BENGAL IN 1930-31 AND FROM 1939-40 TO 1944-45
(All figures in lakhs)

ession	Total population	Rural population of school going (7—17 years)	Number of students	Percentage of col. (4) to col. (3)
(1)	(2)	(3)	(4)	(5)
1930-31	435·1	192·5	21·1	20·6
1939-40	518·4	122·1	29·9	24·5
1940-41	526·4	124·0	31·9	25·7
1943-44	551·8	130·0	27·8	21·4
1944-45	537·5	126·6	26·6	20·9

Education in Bengal, as in the rest of British ruled India, has been exceedingly backward. We have seen from table 9 that in 1940-41, only 31·9 lakhs of children being less than a third of the population of school going age were at school. This is on a par with the educational conditions in Tsarist Russia, just before the revolution of 1917.[8] The percentage of literacy in 1941 was 18%, (excluding the population in the age group 0-5) a figure slightly less than that of Russia in 1917. The cataclysm which has swept over Bengal in 1943, and the aftereffects of it, have put back even this slight "advancement" of education by a dozen years. It would be a truism to state here the importance of education for the progress of a people in life. But it seems nevertheless to be overlooked. A reference to the scheme of rehabilitation by the Revenue Department, Government of Bengal, for example, does not contain any mention of a programme of educational rehabilitation. No communique regarding a scheme of educational rehabilitation has also been published by any other department. The small subsidy granted to some teachers and students for a few months cannot be described by this term.

Unless however the State come forward to co-operate with the general public and local organisations, such rehabilitation will not be possible. In normal times, inspite of the chronic poverty of the people, the major share of educational expenses had been borne in Bengal not by the Government, but by the guardians of the students and the local authorities. Out of a total expenditure of Rs. 255 lakhs on rural as well as urban schools (primary, middle, high) for boys in 1940-41 the Government met only Rs. 59 lakhs. For similar schools for girls the total expenditure for the same period was nearly Rs. 45 lakhs, out of which the Government paid Rs. 14 lakhs. For rural areas, the figures are for total expenses, Rs. 177 lakhs and Rs. 10·8 lakhs for boys and girls respectively and for Government contribution Rs. 45 lakhs and Rs. 4·5 lakhs. The Government is therefore bearing only a fourth of the expenses for boys and about two fifths of that for girls. In consequence, education in rural areas is restricted mainly to the (economically classed) middle and upper strata of the population. While the worst sufferers in the famine were people in the lowest level, the Rehabilitation Enquiry has furnished sufficient data to indicate that a fair proportion of people in the middle layer has been pushed into the lower level, while the people in the upper level have not also escaped entirely from the final effects of the devastation.

Any scheme of educational rehabilitation will therefore have to meet the needs of

A. Children of people who were in the lowest level in the villages prior to 1943 and who have been reduced to destitution or semi-destitution.

B. Children of persons now in the condition of people in the lowest level in normal times.

C. Children of people in the present middle and upper layers.

For those in class A, not only is free education essential, but the children will have to be looked after in other ways. Their parents will need actual relief until they are able to make a living. It should be noted here that the number of such families in-

[7] The population of school going age (high, middle and primary standard) have been considered as under the age group 7+ to 16+ years. In the report on "Post Educational Development in India" the upper limit is taken as 17 years. Hence as education at school starts at a later age in rural than in urban areas 7—16 has been considered as the school going age instead of 6—15. The total rural population under this age group (col. 2) has been calculated from the ratio of this age group to the total population, derived by interpolation from the sample tables of the Census of 1941. The population at the beginning of 1930 (for the session 1930-31), 1939 (for the session 1939-40), 1940 (for the session 1940-41), and 1943 (for the session 1943-44) have been derived by interpolation as noted in (3). Population at the beginning of 1944 (for the session 1944-45) has been estimated from that of 1943 taking into consideration the official estimates (Report of the Famine Inquiry Commission, Bengal, 1945) of mortality rate—44·8 per mille, as calculated from total death of 2·8 millions and the birth rate—18·8 mille during 1943. This may lead to a slight overestimate as a sample survey all over Bengal gives the total mortality as 3·4 millions for 1943. But as the recording of births is also faulty, the error is probably compensated.

[8] History of Russian Educational Policy (1701-1917) by Nicholas Hans, London, 1931.

creased considerably during 1943. Food as well as clothing and books will have to be furnished to the children. For children in class B, free education is the first essential, and also supply of books, as their purchase has always been a difficulty in the way of education of children of this economic level. For children in class C, supply of books and paper etc. at controlled prices is essential.

Sickness among students is largely the result of loss of vitality due to lack of food. The wide spread shortage of milk even in rural areas is a main contributory cause to the delay in recovery. In a short term planning it is difficult to suggest any remedy beyond arrangements for medical aid and supply of milk as sick diet to children actually indisposed and unable to attend school. In any long term planning of economic rehabilitation provision for adequate supply, not only of other food but of milk for children must take a place of importance.

We have noted earlier in this para that the guardians of local authorities bear nearly three fourths of the expenses, in the shape of fees and contribution. If however education is to be free for the greater number of children of families who had previously been paying fees, the school authorities must make up for this loss of income in other ways. As local authorities also derive their income from taxes on the local people who have been hard hit by the famine, these bodies will not be able to do much. The deficit must therefore be met by grants from the Government. Since Bengal as a whole has suffered, and part at least of the difficulties are due to Bengal having been in the War Zone, contributions from the Central Government can be legitimately demanded.

Since the schools paid the teachers poorly in normal times owing to their low receipts and teachers had to supplement their income in other ways (such as private tuition, or other part time work) which are often no longer available, the grants should be sufficient in amount to cover an increase in salary (or a Dearness Allowance) commensurate with the rise in prices.

Appendix I

Sub-divisions classified according to degree of affection in "A Scheme for Relief and Rehabilitation in Bengal"—Revenue Department, Government of Bengal.

Class I. (Most affected)
1. Arambagh
2. Chandpur
3. Chittagong
4. Contai
5. Diamond Harbour
6. Madaripur
7. Manikganj
8. Munshiganj
9. Nilphamari
10. Noakhali
11. Tamluk
12. 24 Parganas

Class II(a) (Moderately affected)
1. Barisal
2. Bhola
3. Calcutta
4. Coxbazar
5. Dacca
6. Feni
7. Goalanda
8. Kandi
9. Midnapur
10. Narayanganj
11. Satkhira
12. Serajganj
13. Tangail
14. Tipperah

Class II(b). (Moderately affected)
1. Bankura
2. Bishnupur
3. Burdwan (s)
4. Faridpur s)
5. Gaibandha
6. Ghatal
7. Hooghly (s)
8. Howrah (s)
9. Kalna
10. Kushtia
11. Pabna (s)
12. Uluberia.

Class III (slightly affected)
1. Bogra
2. Brahmanberia
3. Gopalganj
4. Kishoreganj
5. Kurigram
6. Narail.

Class IV (very slighlty or not affected)
1. Alipur
2. Asansol
3. Bagherhat
4. Balurghat
5. Bangram
6. Baraset
7. Barrackpore
8. Basirhat
9. Birbhum (s)
10. Chittagong Hill Tracts
11. Chuadanga
12. Darjeeling
13. Dinajpur (s)
14. Jalpaiguri
15. Jamalpur
16. Jangipur
17. Jessore (s)
18. Jhargram
19. Jhinaidah
20. Kalimpong
21. Khulna (s)
22. Katwa
23. Kurseong
24. Lalbagh
25. Magura
26. Maldah
27. Meherpur
28. Murshidabad (s)
29. Mymensingh
30. Nadia (s)
31. Naogaon
32. Natore
33. Netrokona
34. Patuakhali
35. Perojpur
36. Rajshahi (s)
37. Ramgarh
38. Rampurhat
39. Ranaghat
40. Rangpur
41. Siliguri
42. Serampore
43. Thakurgaon.

Appendix II

Sub-divisions surveyed as classified according to degree of affection in "A Scheme for Relief and Rehabilitation in Bengal"—Revenue Department, Government of Bengal.

Class I. (Most affected)
1. Arambagh
2. Chandpur
3. Chittagong
4. Contai
5. Diamond Harbour
6. Madaripur
7. Manikganj
8. Munshiganj
9. Nilphamari
10. Noakhali
11. Tamluk
12. 24 Parganas

Class II(a). (Moderately affected)
1. Bhola
2. Feni
3. Kandi
4. Midnapur
5. Narayanganj
6. Satkhira
7. Serajganj
8. Tangail
9. Tipperah

Clas II(b). (Moderately affected)
1. Bankura
2. Bishnupur
3. Burdwan (s)
4. Faridpur (s)
5. Gaibandha
6. Ghatal
7. Hooghly (s)
Howrah (s)
9. Kalna
10. Kushtia
11. Pabna (s)
12. Uluberia

Class III. (Slightly affected)
1. Bogra
2. Kishorganj
3. Kurigram
4. Narail

Class IV. (Very slightly or not affected)
1. Baraset
2. Meherpur
3. Nadia (s)

OBITUARY: DR H. K. SEN

DR H. K. Sen, whose death occurred in Calcutta at the early age of 56 on the 3rd June last, was born at Noorpur, Rajbari, near Goalundo, of a family of middle class intellectuals of East Bengal belonging to the village of Baldhara in the district of Dacca. Dr Sen's father, the late Mr. Prasanna Kumar Sen, was a Deputy Inspector of Schools, and the family had often to be travelling with him and staying in different districts in his range. It was thus that young Sen came to have his early school education at the Annada H. E. School in Brahmanbaria in the district of Tipperah from where he passed the Entrance Examinattion (equivalent to modern Matriculation) in 1904 in the First Division gaining a special scholarship from the School. In July of that year, he came to Calcutta and joined the City College where the writer first came into his contact. The acquaintance begun casually in a college class slowly ripened into one of those rare, sublime friendships the essence of which is a total magnanimity and trust lasting through life. The memories of those early days of college life, of youthful zeal and affection, when a day would never seem to be complete without a friend's meeting in the evening after college hours mostly in the Goledighi (College Square) or elsewhere for a hearty discussion on every subject on earth from college studies and professors to the current social and political events of the day, would remain sweet and fragrant till the end of life.

Sen's educational career in Calcutta began at a time when the whole of Bengal was convulsed with excitement at the partition of Bengal which had just been effected by Lord Curzon, the Viceroy of India. The act aroused country-wide indignation and opposition and the students of Calcutta, under the leadership of the late Mr Surendra Nath Banerji, threw themselves heart and soul into the fight. Sen, a young boy of 15, new to Calcutta, full of ardour and enthusiasm for great ideals, would often be found at the forefront in the numerous students' meetings and processions which were organised at that time. More than political wrongs, the social evils of the country moved Sen deeply, and the discussions and arguments into which he plunged with vigour either with his fellow-students or with others sometimes generated so much heat that it led him into perilous situations from which he had to be rescued by his friends. It is strange to contemplate that a young lad brought up in an orthodox Hindu household, in a remote country-side in East Bengal should have developed a mind so singularly free from bigotry and narrow superstitions of any kind. His eager spirit and restless energy would not allow him to miss any of the cultural activities and students' movements in the city. In the afternoon he would often be found attending the Bible class of Dr Farquhar in the Y.M.C.A. (Overtown Hall) while later in the evenings he would be found eagerly following the lectures on Gita delivered by the late Prof. Benoyendra Nath Sen in the Brahmo Samaj of India.



DR H. K. SEN

After passing what was then styled the First Examination in Arts, Sen continued in the same college and, in due course, took his B.A. degree (B. Course) in 1908. In July that year he joined the Presidency College, Calcutta, for the M.A. Degree course in Chemistry. Physics was his forte in his B.A. Degree course but he took Chemistry for the M.A. degree probably more from his anxiety to be near his old comrade than from any innate love of the subject. The year 1908 was rather an importatnt year in the annals of the University of Calcutta. The new regulations for the M.A. and M.Sc. degree courses were first introduced in that year. The courses in Chemistry were extensive and heavy and there was hardly an advanced treatise in Chemistry published up-to-date which had not been included in the text-books prescribed for the degree. Nobody—neither the students nor the teachers—had a clear

idea as to how much was expected by way of lectures and demonstrations for the new courses. The result was that the students were left almost entirely to themselves for a major portion of both the practical courses and the theoretical studies. Inorganic Chemistry was the main branch of the Science taught in those days and so far as practical work was concerned, the essence of all knowledge on the subject was to be found in Fresenius' book on qualitative and quantitative analysis. The acme of perfection was reached by a student when he could analyse correctly a complete mixture of 20 radicals containing a sulphide, a sulphite, a sulphate and a thiosulphate! Physical Chemistry was then in its infancy in the Indian Universities and so far as practical work in Organic Chemistry was concerned, the preparation and analysis of even a simple organic chemical was considered to be a rare feat and looked on with reverence and awe. The tremendous vitality and energy of young Sen soon made itself felt in the class and he became virtually the leader of the group. Rare and valuable apparatus, which had never seen the light of day being kept hidden in the store room on the topmost floor to which students were forbidden entrance, were discovered and dragged out, sometimes to the great annoyance of the authorities, and new experiments were designed and carried out often working till late in the evening by candle lights. The leading part in these expeditions was taken by Sen and it would be no exaggeration to say that he first set the high standard of experimental work particularly in Organic and Physical Chemistry in the Chemical Laboratories of the Presidency College, Calcutta. At this period Sen had also to carry on a keen struggle with poverty and had to earn the wherewithal to maintain himself and pay for his studies by a number of private tuitions in the city. After a hard day's work in the laboratory and a few rounds in the Goledighi which were not to be missed on any account, Sen would hurry off to the house of a rich merchant or lawyer to coach his dull boy, returning to his poor lodgings late in the night for a frugal supper and rest. By an irony of fate, Sen failed in the M.A. degree examination of 1910 on account of the vagaries of an examiner, a young chemist fresh from Germany who set the examinees the impossible task of carrying out a complete quantitative analysis of type-metal in the course of one day. The result was disastrous and most of the candidates including Sen got a cipher in that particular paper. The next year (1911) Sen passed with a First Class obtaining record marks in Organic Chemistry and the year after (1912) he won the Premchand Roychand Scholarship which is rightly regarded as the blue ribbon of the Calcutta University. In the intervening period of 1910 to 1911 Sen conducted two pieces of research in both of which the writer had the privilege of collaborating with him. The results of these investigations were communicated to the *Zeitschrift für anorganische Chemie* of that year. The pioneering work of Prof. P. C. Ray on the nitrites of mercury made the chemistry of nitrites the main theme of research in the Presidency College laboratories in those days, and the first piece of investigation in which Sen and the writer collaborated dealt with the inter-action of nitrites with hydrazine salts. The paper was reviewed favourably in the annual reports on the Progress of Chemistry for 1911. In the summer of 1912, Sen went to London and joined the Imperial College of Science and Technology as a research student working for the degree of Doctor of Science of the University of London. During the period of 3½ years of his stay in London, a series of communications embodying the results of his researches mostly on the condensation of ketones and ketonic bodies with phenols and naphthols appeared in the *Proceedings and the Transactions of the Chemical Society, London*. Sen was awarded the Degree of the Doctor of Science of the University of London in the summer of 1915 chiefly on the merit of an important piece of investigation on the mechanism of the re-activity of cyanoacetamide in its various condensations, the degree being awarded for the first time to an Indian candidate working as an internal student of the University of London. On the 4th July, 1914, England declared war on Germany and a wave of intense enthusiasm and excitement passed over the Imperial City. Everything was immediately subordinated to war work and the research activities of the Imperial College were shunted off to scientific problems arising out of the war. Two main problems which were allotted to the research students of the Organic Chemistry Department of the Imperial College at this time were those on (1) the preparation of lachrymatories (tear producing gas), and (2) the production of a number of important drugs, chiefly local anaesthetics, supplies of which had been completely cut off, as they had hitherto been imported exclusively from Germany. The two local anaesthetics which were chosen for the workers in the Imperial College were—novocaine and β-eucaine, Sen being chosen as the leader of the band was allotted the task of working out a process for the preparation of the latter. It was in the winter of 1914 that Sen, undaunted by a number of failures, ultimately succeeded in preparing this drug for the first time in England. A gram of (laevorotatory) β-eucaine was exhibited by Prof. Jocelyn Thorpe at the Thursday evening meeting of the Chemical Society in Burlington House, Piccadily, and it was a proud moment for Sen when he received an ovation from the assembled chemists including the President, the late Prof. W. H. Perkin, Jr. of Oxford, on his success. The process for making β-eucaine first

worked out by Sen was later made over to Boots & Co., for the commercial production of the drug on a large scale.

The years 1912—1915 were some of the most fruitful years of activity in Sen's life. He came to England, a stranger with no credentials except the M.A. degree of the Calcutta University and reprints of two papers in Inorganic Chemistry published by him, and he left England a reputed and respected Indian chemist admired by a host of English friends equally for his skill in experimentation and for the brilliance of his exposition. One must record with gratitude the active sympathy and help which the two unknown young Indian researchers—the only representatives of their country at the time taking part in scientific research in England—received at the hands of many of the Professors of Chemistry in London at that time. The names of the late Professors Sir Edward Thorpe, H. B. Baker, Sir M. O. Forster and Jocelyn Thorpe deserve special mention in this respect. After the first year, not only were they exempted from payments of all fees but they were helped every year in obtaining substantial research grants from the Chemical Society and other learned bodies for the purchase of expensive chemicals and apparatus. After obtaining his Doctorate degree, Sen was offered by Prof. Baker a well-paid research assistantship, if he cared to continue in London, but Sen felt very home-sick and in the autumn of 1915, he returned to India to the regret of his numerous English friends in the Imperial College and elsewhere. On his return to India, Sen made a few abortive attempts at starting a chemical industry in Calcutta which failed mainly on account of the lack of capital, and in the summer of 1916 he obtained a place as chemist with Tatas at Jamshedpur where however he stayed only for a few months. His restless spirit, eager for new experiences and achievements, led him to Burma where he secured employment successively under a number of rich industrialists like the late Osman Jamal, DeSouza and others. The Armistice of 1918 was followed by a great industrial boom in India and several commissions like the Indian Industrial Commission presided over by the late Sir Thomas Holland and the Indian Chemical Service Commission presided over by Prof. Jocelyn Thorpe came to India at that time. Sen, full of energy and ideas for new chemical industries, travelled widely all over India in 1918 gathering materials for a report on the possibilities of new chemical industries in Burma, on behalf of his employers in Rangoon. It was in Rangoon that Sen met his future wife, Miss Kalpana Rani Sen, the eldest daughter of the late Mr Nirmal Chandra Sen, a flourishing barrister of Rangoon and grand-daughter of the famous poet, Nabin Chandra Sen of Chittagong. The marriage which took place in 1917 proved most happy but alas, a very short-lived one. In the summer of 1920 Sen lost his young wife as an accident in child birth. Life in Rangoon full of sad memories of his dear wife became painful to him and a change was eagerly sought. Fortunately, it was at this very moment that the late Sir Asutosh Mukerji was looking about for a suitable person for appointment to the newly created Chair of Applied Chemistry in the College of Science in Calcutta and he immediately offered it to Dr Sen. The appointment was accepted and Sen returned to Calcutta in the autumn of 1920. The chair of applied chemistry in the University of Calcutta was filled by him with great distinction for more than a decade and a half during which he established a reputation all over India as the most outstanding applied chemist in the country. The series of communications in pure and applied chemistry issued from his laboratory and the text-books and monographs published by Sen testify to the valuable work in teaching and research done by him during this period. The present position of the Department of Applied Chemistry in the University College of Science, Calcutta, can, without any fear of contradiction, be attributed to his able guidance and devoted service ; and most of the present extension of its laboratory and workshop bears the stamp of his handiwork. For, the entire scheme was developed by him and this was already in blue-print before he left the university service. Numerous were the industries particularly those in and near about Calcutta which benefited by his expert advice and his room in the College of Science was always crowded with men seeking his help and advice. It was a characteristic trait of Sen's nature not to refuse help to anybody and he never spared himself in the service of others. One has a feeling of regret at times that it should have been so, for it undoubtedly prevented the finer intellectual gifts which Sen possessed from being turned to better account in achieving greater things in the realm of science. During his period of professorship in the College of Science, Sen went abroad twice on deputation from the University of Calcutta. These periods of leave were periods of strenuous labour spent in carrying out researches in bio-chemistry in collaboration with Professor Neuberg and others in the Kaiser Wilhelm Research Institute at Dahlem and in improving the technique of high-pressure reaction experiments with Bone and others in the Imperial College of Science, London. These labours resulted in the publication of several important papers on problems of fermentation and also on high-pressure re-actions, jointly and independently, and the taking of a patent jointly with Professor Neuberg. It was during one of these long periods of study in Germany that Sen met the eminent microchemist, Prof. Emich of Graz (Austria) and her daughter, Fraulein Fritzi Emich, while attending a

conference at Vienna. The acquaintance with Fraulein Emich gradually grew into intimacy and love through long correspondence after Sen's return to India, which eventually led to their marriage in 1933 when Sen went to Europe again to attend on invitation the Power Conference at Berlin. In 1936 the post of Director, Lac Research Institute at Ranchi fell vacant and Sen was offered and accepted the post. The duties of the post were congenial to Sen and he threw himself with his characteristic vigour into the work and brought new life to the Institute. His most important researches during this period lay in the field of plastics and many important memoirs and papers were issued from his laboratories at Ranchi. Several improvements in the commercial production of shellac and in the manufacture of special compositions for useful articles, like gramophone records, electric insulators, etc., were carried out. The Government showed its appreciation of his work by an extension of his service for another period of 5 years. Sen served on many committees of the Government of India during the present war either as Chairman or as member, and last year, the Government of Bihar requisitioned his services as Director of Industries to help them in their extensive schemes of post-war industrial development. Incessant labours and domestic and financial worries had however told on his health during the last few years and rest was sorely needed. His tireless spirit could however find no rest or recreation except in work, and in spite of numerous warnings of nature and the appeals of friends, he continued his strenuous labours till the last. On the 8th of December last he came to Calcutta in connection with the marriage of his son and soon after arrival he had a serious break-down. He had no option but to take to bed immediately, probably for the first and the last time, and in spite of every effort of his friends and his loving relations, he passed away peacefully on the 3rd June leaving his numerous friends and relations throughout India heart-broken.

Sen had a very lovable disposition and was of a most affectionate nature, quickly making friends even amongst utter strangers. He was generous to a fault, his transparent sincerity and selfless disposition made him not infrequently a victim of exploitation by others. Those of us who had the privilege of mixing with him intimately know that his greatness as a scientist was matched by his goodness as a man. His big energetic exuberant lovable personality and his simplicity and genius for friendship can never be forgotten. Though honours and riches were showered on him lately he remained unassuming and absolutely unspoilt. He was a good speaker, being one of the few scientists who could make an impressive speech extempore. His numerous students in India can testify to the excellence of his lectures. In 1927, Sen was elected President of the Chemistry Section of the Indian Science Congress held in Lahore. His splendid address will be remembered by all who were present at its delivery. Sen was never a narrow-specialist but his interests embraced a very wide range of subjects. He could lecture equally well on a subject of Physical Chemistry, Organic Chemistry, Bio-chemistry or even Mineral Chemistry. It was his sound fundamental training in Physics and in Chemistry which stood him in good stead in his many-sided activities and enabled him to help chemists and industrialists and even educationists in different directions. He was elected President of the Indian Chemical Society in 1940 and that of the Indian Institute of Chemistry for two different terms in 1930 and 1935. It was mainly through his initiative that the latter body came into being. He was the Foundation Fellow of the National Institute of Sciences of India. By the death of Dr Sen the scientific world of India suffers a loss that is truly irreparable. We have no one today whom we can put into the niche into which he had fitted himself so well by his painstaking and conscientious work. In him we lose not merely a chemist but a scientist, an educationist and an industrialist of the first magnitude whose social virtues made him a fitting intermediary between the laboratory workers and the world outside. Endowed with a kind and sympathetic heart, which knew no pettiness, coupled with a genial temperament and rare frankness he endeared himself to all who came in contact with him, and particularly to his pupils who, without a single exception, had nothing but love and high regard for his magnetic personality. We find in him the ideal of a sincere friend, an attractive teacher, a trusted colleague, and a compassionate and benevolent master, which will serve us to do our duty of keeping his memory green. Dr Sen has left one son and his widow now in Graz and a very large circle of friends in India and abroad to mourn his loss.

B. B. Dey.

Notes and News

SOAP CONFERENCE AND DIPLOMA IN SOAP TECHNOLOGY

THE holding of the annual conference of soapmakers under the auspices of the All-India Soapmakers' Association, now in the 11th year of its existence, was resumed this year at New Delhi (February 18, 1945) after a brief period of abeyance necessitated by war time difficulties. The conference presided over by Mr R. S. Patnek was opened by the Hon'ble Sir A. Ramaswami Mudaliar, K.C.S.I. and was largely attended by distinguished scientists and industrialists from all over India. The President, in his address, referred to the difficulties facing the Indian soapmakers in their effort to expand the industry for which great opportunities exist. The Government's unsympathetic attitude with regard to a more liberal supply of essentital raw materials such as caustic soda, coconut oil, coal, essential oils, wrapping paper, etc. constitutes the most difficult hurdle in the way of the industry. Besides, a number of short sighted bans, controls and ordinances, such as the ban on the inter-provincial movement of soaps by certain railways, to mention only one, have condemned the industry to a relatively unimportant position.

In view of these and other difficulties, the conference was unanimous in passing resolutions which relate to (1) the granting of licence to import waxpaper for wrapping soaps, (2) the removal of ban on inter-provincial movement of soaps over certain railways, and (3) the granting of facilities for import of perfume materials and compounds from U.S.A. and other allied countries. With regard to the import of perfume materials from the U.S.A., mention may be made of several abortive attempts by the Association to obtain the necessary facilities. Although the Governments were prepared to permit import of U.S.A. essences through U.K., they would not allow direct import on the pretex of dollar exchange difficulties, knowing full-well that direct import would be considerably cheaper.

The University of Calcutta, the secretary reported, has approved of a scheme for soap diploma course sponsored by Dr M.N.Goswami, of the Department of Applied Chemistry, University College of Science and Technology, and an honorary member of the Association. The syllabus has been prepared very carefully in consultation with soapmakers. The Association proposed to make a non-recurring grant and suggested that the University should be responsible for any recurring expenses. The scheme was discussed in the conference and it was resolved that a minimum contribution of Rs. 1,500/- be fixed for each member of the Association.

We learn that at a special meeting of the Senate of the Calcutta University held recently, the Senate has accepted the proposed scheme and has made provision for Rs. 5,000/- as a recurring grant. The nonrecurring capital grant to be paid by the Association has been fixed at Rs. 15,000.

A number of technical papers were read and discussed at the conference. The office-bearers and members of the Executive Committee, elected for 1945, include Rai Bahadur Seth G. M. Modi, as the President, while Mr S. C. Ghose continues as Secretary.

THE PULP AND PAPER INSTITUTE OF CANADA

THE prosperity of Canada depends, to a large extent, on her forest resources. It is no wonder, therefore, that the pulp and paper industry is the largest manufacturing industry of that country. In normal times India used to import practically all the newsprint (she produces not an ounce) from Canada, as also Great Britain had a good proportion of her supply of paper and pulp from there. It is also natural that the industry should have its research institute well organized, for without scientific research no industry can prosper or even hold its own for a long time. That the Canadian Government as well as the industrialists fully recognize this fact is evident from the annual report of the above institute for 1940-41.

By an agreement, the institute is managed by a joint administrative Committee consisting of representatives from the Government of Canada, the Canadian Pulp and Paper Association, and the McGill University. The fundamental object of the agreement is the complete unification of research work. The entire programme of work done in the institute is laid down and controlled by this administrative Committee. Any work to be done for individual members of the Association or for allied industries must have the previous sanction of the Committee. Consulting working done by individual members of the staff of the institute has also to be approved by the Committee in addition to the director of the institute. The financial position of the institute is quite sound as it should be ; a fixed annual income is

guaranteed by the three parties. This enables the authorities to plan and execute long-term research projects which would have been otherwise impossible.

By the abovementioned agreement, the Government of Canada contribute annually $38,000 to the institute, together with half the cost of maintenance and administration cost of the premises ; the McGill University gives the institute every year $12,000 plus the other half of the aforesaid cost, while from the Association, it receives $60,000 per year. The contribution of the University to a technical research institute would appear to many of our countrymen as rather unusual.

The choice of programme for research is naturally governed by the facilities available at the institute and also the order-of importance of the problems to be taken up. The work of the institute may be broadly classified under three heads: testing work, fundamental research and applied research. It appears from the report that the authorities are very particular about maintaining a clear-cut division among these three types of research, and furthermore, they consider them equally important. This is a very healthy sign. Unfortunately, this attitude is lacking in most of our research institutes. The conduct of research work on raw materials, and on the processes and the finished products of the Canadian pulp and paper industry, with special reference to the requirements of the industry, is an important function of the institute.

Unlike mineral wealth which is distributed unevenly on the world, the raw materials for the paper and pulp industry are found almost everywhere. So it cannot be the monopoly of any one nation. The survival of the fittest amongst the competitors in the world market for this product is mainly, if not wholly, dependent upon well planned scientific research. The institute authorities recognize this fact and formulate their scheme of research accordingly.

Roughly, one tenth of the activity of the institute is allocated to testing work which, however, is accepted under certain conditions. Mills have to pay for the tests done for them by the institute. Routine tests which can be done in a mill laboratory are not accepted. It does not also accept tests which are to be utilized for the purpose of advertisement. These are quite good arrangements. A research organization should, as far as possible, be busy with research work and not routine tests.

Fundamental research is chiefly directed towards helping the industry in designing improved equipment and processing, devising new methods of recovery of waste products, and so on. Applied research is the ultimate objective of the institute ; it is gratifying to note that the authorities recognize the oft-misunderstood fact that it is futile to undertake applied research alone without fundamental research. One has to wait patiently for the outcome of applied research ; operational difficulties of mills which apparently seem to be due to obscure causes are solved by applied research. It also helps the industry in attaining better and improved control work in the mills and in utilizing the waste liquor as well as waste wood in various ways. One-third of the resources available after allowing for administration, maintenance and testing is allotted to applied research and one-third for fundamental research, the remaining being spent for projects lying outside the field.

A CENTRAL FILM ACADEMY AND RESEARCH LABORATORY

We welcome the proposed establishment of a Central Film Academy and Research Laboratory under the joint auspices of the Independent Film Producers Association and the Indian Motion Picture Producers Association. Apparently the lead has been taken by the Independent Film Producers Association which, at a meeting held in Bombay on March 26, 1945, unanimously resolved to establish a central institute in India for the training of technical talent, to assist the promotion of the film industry, and to put it on a much wider and stabler foundation. A fact finding Committee, with Sir Homi Mehta, the leading industrial magnet of Bombay, as chairman, and Mr A. Lalljee, M.L.A. (Central), Mr C. V. Deshmukh, M.L.A. (Central), Prof. M. N. Saha, Prof. K. S. Krishnan, Dr K. A. Hamid, Dr K. Venkataraman, Dr Nazir Ahmad, and Prof. B. B Deshpande and two representatives of the film industry as members, was appointed to investigate the possibilities of starting such a central institute. Three sub-committees were set up to deal with various technical problems which the establishment of an institute of this nature necessarily involves. These are: (1) Chemical Sub-Committee to consider all questions relating to raw films, sensitizing dyes, photographic chemicals etc., (2) Instrument and Machinery Sub-Committee to deal with problems relating to optical lenses, instruments, cameras, projectors, accessories etc., and (3) Motion Picture Technique Sub-Committee to work out plans for central training institute, curriculum etc.

The Central Film Academy and Research Laboratory, when established, will remove the long-felt need for a scientific film institute. It is reported that India is now the third film producing country in the world and comes only after the United States of America and Japan in the volume of film production. The annual production of pictures in India during the last several years has been averaged at 150. The film industry is wholly dependent on foreign supply

of raw films, photographic sensitized materials, machinery and other equipments, and it is not difficult to realize the extent of the drainage of money the import of these goods involve. It is estimated that raw film and photographic sensitized materials worth Rs. 60 lakhs are imported annually. If one takes into account import duties on raw film and machinery, entertainment tax and other taxes imposed by the Central and Provincial Governments, the money the film industry is required to pay to the Central Exchequer amounts to the colossal sum of about one and one fourth crores of rupees. The sponsors of the Academy must be congratulated on their new endeavour which deserves full public as well as Government sympathy and co-operation.

INDIAN DECIMAL SOCIETY

SINCE we wrote last month on the Government's proposal to decimalize the Indian coinage system, our attention has been drawn to the 'Indian Decimal Society', an organization newly constituted '(1) to propagate the utility of the Decimal System and popularize its practical use among our country men in everyday life, (2) to formulate a scheme for reforming and standardizing all over India coins, weights and measures on the basis of the Decimal System, and (3) to organize countrywide agitation for getting the approved scheme adopted by the Government and consequently for abolishing the use of all other unscientific systems'. The objects and aims of the Society are thus stated in clear and unambiguous terms and will satisfy the scientific and the enlightened sections of Indian public in favour of introducing the decimal system. We note with great satisfaction that the activities of the Society do not only concern coins, but embrace the whole problem of reforming and standardizing weights and measures as well. It is wedded to a policy of simultaneous and compulsory adoption of the metric system in coins, weights and measures all over India and undertakes to organize countrywide agitation.

We are not prepared to believe that the Government as constituted at present will readily undertake reformation in weights and measures of such a far reaching character, although they have indicated their sympathetic attitude by choosing to decimalize the coinage system. A strong public opinion in favour of introducing the metric system such as now works in most of the civilized countries of the world can alone induce the present Government to adopt this scientific system. The Society, we trust, can play a very useful part in educating the public in the relative advantages of the metric system and thus in moulding a favourable public opinion. For details of the Society, our readers may be referred to Mr Phanindra Nath Seth, Secretary, Indian Decimal Society, 20/1A, Baldeopara Road, Calcutta.

FISHERIES IN BARODA STATE

THE sixth annual report of the Department of Fisheries, Baroda State, gives an encouraging record of activities of the Department for the year 1942-43, that deserves emulation by the British Indian Provinces.

Apart from a general survey and collection of biological specimens round about Baroda and fresh water fish culture experiments, very encouraging work is being done on fish preservation, fish oil industry, fish manure and shell fisheries. Work on the shark liver oil *e.g.*, extraction of oil and preparation of medicated oil, was continued during the year under review, and the results obtained were more encouraging than those of the previous years. The output of neat oil was 1,256 lbs. as against 1,100 lbs. in 1941-42, and the price fixed was Rs. 2/- per maund. The semi solid refuse (sipha) left after the refining of the neat shark liver oil was in great demand for painting boats. Shark liver oil has at present a very good market and advantage should be taken to improve the quality of the edible sale oil. Expenditure under this head amounted to Rs. 3,659/- and receipts to Rs. 5,994/- as against Rs. 3,628/- and Rs. 2,804/- respectively in the previous year.

Experiments on manure conservancy with the fish offal, prawn and other crustacean offal, and marsh plants—the seablite and marsh samphire were continued. A powder 'prawn meal dust' prepared from prawn offal is stated to be a good general fertilizer and could be very well utilized as a substitute for shales.

Owing to the difficulty of rail transport, conches collected could not be sent to Dacca, and attempts are now being made to open a bangle factory at Okha. Dead oyster shells for use as poultry food were prepared for sale. A scheme for experiments in curing, pickling and smoking of fish was accepted by the I.C.A.R. Socio-economic work among fisheries and a scheme for the colonization of the latter were continued.

A preliminary report on "the fresh water prawns of Baroda" is detailed in the Bulletin No. V (1944) of the Department of Fisheries, Baroda State. A statistical survey of the fish in the Baroda State revealed that fresh water prawns (Jinga and potia Jinga) ranked first among the different kinds of fish caught and brought to the market, both in quantity and value. The prawn usually collected was *Palaemon carcinus Fabr.*, and no non-vegetarian dinner in Baroda is complete without it. The supply is, how-

ever, irregular, and to remedy this a prawn farm has been opened at Dadhar. The bulletin details the morphological characters and biological habits of the prawns collected at Baroda, which have made it a very useful publication.

INDIAN CENTRAL TOBACCO COMMITTEE

THE Government of India have decided to set up an Indian Central Tobacco Committee on the lines of similar other commodity committees for jute, cotton, etc. In view of the importance of tobacco as a valuable commercial crop and the variety and complexity of problems relating to its production, processing and marketing, the establishment of such an organization is a move in the right direction.

The functions of the Committee will be to assist in the improvement and development of the production and marketing of tobacco and all matters incidental thereto. The Committee will specially devote attention to the improvement of the flavour and aroma of Indian tobacco, and research on these problems will be shortly taken up. The Committee will be financed by the Government of India with an annual grant of Rs. 10 lakhs.

UNIVERSITY OF CALCUTTA

Diploma Course in Journalism

THE Senate of the Calcutta University, at an ordinary meeting held on June 23, 1945, accepted a scheme of introducing a diploma course in journalism in the University. The scheme, in its present form, proposes to give young graduates and candidates having previous experience in the office of a newspaper or a news agency such training as would qualify them for reporters, sub-editors, assistant editors, and business managers in newspaper offices. The candidates intending to take up the diploma course should possess a good knowledge of English and of at least a major Indian language and must have a knowledge of shorthand and typewriting.

The course would include theoretical and practical subjects. In theoretical, there would be papers on principles and history of journalism, the making of a journal, general knowledge of political and socio-economic developments, general outlines of constitutional law and the laws of the Press, and any two of the following subjects: literature and art, scientific and cultural trends, and business of journalism. Practical papers would include development of the idea of news sense, classification of news items, making press notes, etc., preparation of news out of postal correspondence, editing of telegrams, art of reporting, and precis writing, proof reading etc. The University further proposes to arrange, in collaboration with the Indian Journalists' Association, special lectures on subjects of interest to the journalists.

This is an attempt to place the profession of journalism on a more solid and secure foundation for which no praise will be too small. Dr B. C. Ray, moving for the institution of the diploma course, rightly observed that the journalists had so long been trained by passing through the process of trial and error. It is true that, even in the absence of a systematic University training in journalism, India has produced quite a number of journalists of eminence. But it will be a great mistake to advance it as an argument against the institution of a course in journalism in a University, the need of which is now greater than ever before in view of the complicated nature of managing the affairs of a modern newspaper. It is very encouraging to note that the Indian Journalists' Association have lent their active support and co-operation to the Calcutta University in its new endeavour to institute the course.

In this connection we like to invite the attention of the University to the importance of training science graduates in the art of scientific journalism. The display of news from the laboratory is now widely recognized as an indispensable feature of newspapers catering to a modern society based on developments in science and technology. Leading American and European newspapers maintain science editors on their staff, and before long this practice will have to be followed in this country if Indian papers are to serve a modern public to their full satisfaction. This should involve the training of a fairly large number of science news writers and editors, and it is an opportune moment that the University should seriously consider the question of their training.

Prof. S. N. Bose as Guruprasad Singh Professor of Physics

WE learn with great satisfaction that the Senate appointed Prof. S. N. Bose Guruprasad Singh Professor of Physics. Guruprasad Singh Professorship in Physics, it may be recalled, fell vacant by the untimely death of Dr B. B. Ray. Prof. Bose is a physicist of international repute; his outstanding work in statistics has led to the development of the famous Bose-Einstein statistics with which to count photons. Recently he has been carrying on important researches on chemical problems.

An old alumni of the Calcutta University, Prof. Bose served this University as a Lecturer in Physics during 1916-21. In 1921, he joined the newly established University of Dacca as Reader in Physics and was appointed Professor in the same University in 1927. His return to the *alma mater* after 24 years will be rejoiced by his former colleagues and the present research workers and students looking up to him for new inspiration and guidance in the field of learning and research.

Dr N. R. Dhar as Guruprasad Singh Professor of Agriculture

THE decision of the Senate to appoint Dr N. R. Dhar Guruprasad Singh Professor of Agriculture will be received with great pleasure in all quarters. One of the most distinguished disciples of late Sir P. C. Ray, Dr Dhar took his M.Sc. degree of the University of Calcutta in 1913 and worked at the Imperial College of Science and Technology, London, and at the University of Sorbonne, Paris, where he received his doctorates. Dr Dhar served the University of Allahabad as a Professor of Chemistry for nearly 20 years and was the Dean of the Faculty of Science. The munificent endowment of approximately one lakh of rupees which he had recently made to the Calcutta University towards the creation of a University College of Agriculture was reported in our April 1945 issue. We hope that his appointment as a Professor of Agriculture will herald the beginning of a new phase of agricultural research in this part of the country.

Mr W. L. Voorduin as Special University Reader

We further learn that Mr W. L. Voorduin, Chief Planning Officer of the Tennessee Valley and at present Member of the Central Power Commission has been appointed a special University Reader. He will deliver a course of lectures on the hydrological planning of the Tennessee Valley, the multipurpose development of the Valley under flood prevention, navigation, power generation, and soil conservation, and the application of the TVA methods to Indian rivers.

AGE OF THE SALINE SERIES IN THE SALT RANGE OF THE PUNJAB

THE symposium on the above subject will be continued at a joint meeting of the Indian Academy of Sciences and the National Academy of Sciences at Udaipur in December next. Announcing this decision, Prof. B. Sahni, F.R.S. invites all geologists interested in the subject to attend the session and contribute papers. An excursion to some of the critical sections in the Salt Range will be arranged, prior to the date of the meeting. All communications meant for advance printing should reach Prof. Sahni, by the middle of October.

The age of the Saline Series in the Salt Range is a highly disputed point and formed subject of an animated discussion at the last symposium of the Academy, held at Poona in December last, in which many eminent geologists participated. In fact, the entire presidential address of Prof. Sahni was devoted to this question, which was already reported in an earlier issue (*Science and Culture*, Vol. 10, No. 10).

CENTRAL FOOD TECHNOLOGICAL INSTITUTE

ADDRESSING the first meeting of the panel of scientists formed to advice the food department on food technology (see SCIENCE AND CULTURE, X, p. 542) Sir J. P. Srivastava, Food Member remarked that "India is pre-eminently a country where food technology should have reached a high water mark of development". The problem of food rests principally on three pillars:—

(1) The production of raw foodstuffs.
(2) The food technological industries including the preservation, processing and fortification of foodstuffs, vitamin technology, and all related problems.
(3) The distribution of food to the population according to physiological needs.

The second set of problems confronts India specially, and our economic losses owing to spoilage of foodstuffs of all kinds, must be running into tens of crores of rupees. With a well-organized food industry it is intended to (1) prevent or diminish spoilage, (2) remove foodstuffs from seasonal gluts thus preventing waste and making them available in other seasons, (3) increase or retain, the nutritional value of foodstuffs and (4) produce new foods like yeast, synthetic vitamins, vitamin concentrates, etc.

Modernization and expansion of the fishing industry, linked up with the installations of adequate cold-storage facilities, large-scale establishment of fruit dehydration and canning industries, expansion of shark liver oil, production and the creation of a food technological institute are some of the proposals under consideration by this committee for the permanent improvement and greater variety of India's food supply.

There can be no conflict of opinion on the importance of a Central Food Technological Institute, as a more scientific food and nutrition policy is a widely recognized need.

LADY TATA MEMORIAL SCHOLARSHIPS AND GRANTS FOR THE YEAR 1945-46

THE Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Tata, which falls on the 18th June, the awards of the following scholarships and grants for the year 1945-46.

I. International Awards for research in diseases of the blood with special reference to Leucaemias:—(1) Dr P. A. Gorer, London; grant £702; (2) Dr A. H. T. Hobb-Smith, London; grant £100; (3) Dr Werner Jacobson, Cambridge; grant £300; (4) Dr (Miss.) P. Hammick—to work under Prof. Witts to confirm Dr Jacobson's research; grant £400.

II. Indian Scholarships of Rs. 150/- per month each for one year from 1st July 1945 for scientific in-

vestigations having a bearing on the alleviation of human suffering :— (1) Mrs Alemala Venkataraman, B.A., M.Sc., Synthesis of Sulphanilamide derivatives, Haffkine Institute, Bombay ; (2) Mr S. Dattatreya Rao, B.Sc. (Hons.), Investigations on the Synergy between Vitamins A & E and functions of Carotene and Vitamin A in the Animal System, Indian Institute of Science, Bangalore ; (3) Mr L. D. Sanghvi, B.Sc. First Class, M.Sc., Genetical study of blood groups and diseases with special reference to malignant Tumours and Erythroblastosis Foetalis in Bombay ; Tata Memorial Hospital, Bombay ; (4) Mr T. A. Venkitasubramanian, B.Sc., Synthesis of Antiparasitic agents against tropical diseases other than malaria with special reference to Amaedines and Organometallic Compounds, Maharajah's College, Ernakulam ; (5) Mr G. Balasubramanyam, M.Sc. First Class, Insulin Derivatives and Carbohydrate Metabolism, Indian Institute of Science, Bangalore ; (6) Mr T. K. Wadhwani, B. Pharm., Mechanism of the mottling of teeth, Indian Institute of Science, Bangalore ; (7) Mr Rabindra Kumar Basu, M.Sc., Synthesis of Vitamin C (l-ascorbic acid), University College of Science and Technology, Calcutta ; (8) Mr Kalipada Mukherjee, M.Sc. Research on Food Yeast, Biochemical Laboratories, University of Dacca, Dacca.

OUR EDITOR IN U. S. S. R.

READERS of SCIENCE AND CULTURE will learn with great pleasure and pride that Professor Meghnad Saha, F.R.S., Palit Professor of Physics, University College of Science, Calcutta, and one of our editors, has joined the 220th anniversary celebration of the U.S.S.R. Academy of Sciences in acceptance of a personal request from President Komarov. The statement he issued, on his arrival at Moscow, reflects his great interest in Soviet Science. "We are specially interested", said he, "in the works of Academician Kapitza and Joffe, and I hope to become acquainted with them personally. I would also like to study the details of State planning in the U.S.S.R., as I am an ardent supporter of State planning."

Professor Saha is the only Indian scientist to have attended this historic celebration. We fervently believe that his experience in Soviet Russia will be of great help to Indian scientists and to all those engaged in planning in their effort to work out a unified plan for reconstruction and development in post-war India.

SCIENCE IN INDUSTRY

NEW X-RAY DIFFRACTION APPARATUS

A NEW X-ray diffraction apparatus developed by the Philips Company and claimed to be an integral and self-contained unit suitable for use in connection with both university and industrial research has been described in *The Chemical Age*, April 28, 1945. In the usual arrangement for the study of X-ray diffraction patterns, the tube, the high tension generator, and the control panel constitute separate units, with provision for electrical connections. In the present apparatus, the X-ray tube equipped with a filament as the cathode is mounted on the top of a cabinet which houses in its base the high tension generator and has the control panel mounted in the front. Thus integrated, the high tension generator, the tube and the control panel have formed a very compact arrangement which has decided advantages over the older one now widely in use.

The high tension generator includes the tube filament transformer and is provided with two oil immersed rectifying valves which ensure full-wave rectification.

The tube is inserted in the housing and secured by four screws on the top of the cabinet. It is constructed from a beaded bronze casting and is accurately machined. It has four windows of Lindemann glass, which are machined to an angle of 6° to the vertical and provided with four tapped holes. These holes make possible the use of special devices *e.g.*, monochromators ; a rotatable disc carrying the filters and built into each window housing can readily bring into position the appropriate filter. The internal construction of the cathode assembly ensures an un-contaminated radiation. Anti-cathodes of W, Mo, Cu, Fe, Co, and Cr are supplied. For W, Mo, and Cu, the maximum continuous ratings are 1000 watts, and for Fe, Co, and Cr, these are 600 watts. The tube support, the window housing and H.T. generator are water cooled. A protective relay shuts off the apparatus as soon as the pressure of water rises above or falls below a certain pressure.

The control panel is conveniently sloped and indirectly illuminated. It allows stepless variation, from 10 to 60 kvp, of the high tension. The filament current is read on a 0-5 mA. meter and can be accurately regulated and stabilized. A main switch, overload circuit breaker, press-button H.T. switch, pilot light and an hour meter for recording exposures

and tube life are other notable features of the control panel.

Optically worked camera tracks of various lengths, complete with all necessary adjustments and locking devices, can be fixed to the instrument table on the top of the cabinet. On these tracks can be fitted powder cameras of either 57·3 or 114·59 mm. effective diameter, flat-film camera, low-angle camera, precision "back-reflection" focussing camera, and a Weissenberg camera of 57·3 mm. diameter.

A NEW VITAMIN A

Mr C. D. Robeson and Dr J. G. Baxter, of Distillation Products, Inc., Rochester, New York, have recently succeeded in isolating from fish liver oils a substance which has vitamin A activity (*Nature*, March 10, 1945). The new compound differs in properties from the vitamin A previously obtained in crystalline form (designated as A_1 by the authors) and, according to a preliminary bio-assay, has been found to possess nearly the same potency, both in kind and in magnitude, as the latter.

The new vitamer, a term introduced to indicate two or more substances having the same ability to cure a single deficiency syndrome, crystallizes as light yellow needles (m.p. 59-60°), whereas vitamin A_1 crystallizes as yellow prisms (m.p. 62-64°). The absorption maximum at 328 mμ for the new compound compares favourably with that of vitamin A_1 at 325 mμ. Chemically, the new vitamer is an alcohol and gives rise to a red anthraquinone carboxylate having a melting point at 130-131°, whereas a corresponding yellow ester with melting point at 123-124° is obtained from vitamin A_1. Both the vitamers, when treated with alcoholic hydrochloric acid, form the same anhydro-compound.

The composition of the new vitamer has not yet been ascertained. From the studies so far made, it appears to be geometrical isomer of vitamin A_1. The authors have developed two methods for estimating the percentage of the new vitamin in fish liver oils and concentrates and have shown that soupfin shark and dog fish liver oils contain 30% and 33% respectively of the new vitamer.

The existence of more than one vitamin A capable of curing a single deficiency syndrome makes the question of nomenclature very important. The authors consider the use of subscripts unsatisfactory and suggest that the A-vitamins in fish liver oils be named from the genus of fish in which they occur. Thus 'gadol' for vitamin A from *Gadus*, the cod, and 'galol' for the new vitamin from *Galidae*, the shark may prove satisfactory, and these suggested terms are now under consideration by the Committee on Biochemical Nomenclature of the U. S. National Research Council.

INDIAN PENCIL WOODS

M. A. Rehman and S. M. Ishaq, of the Forest Research Institute, Dehra Dun, have compiled valuable information regarding Indian pencil woods, published in the Indian Forest Leaflet No. 66 (utilization).

About 80 different species of Indian woods were tried by various pencil factories, of which only *Juniperus macropoda* found in Baluchistan was recommended for first class pencils. This wood is as good as American cedar and is even superior to the East African cedar. Owing to high cost of transport of this wood from the forest to the saw mill, this was an uneconomical proposition, and it is only recently when the supplies of American cedar (*Juniperus Virginiana*) and East African cedar (*Juniperus procera*) have almost ceased that Baluchistan Juniper is being exploited for the pencil trade in this country. After making a study of the exploitation and marketing of Baluchistan woods, the Forest Research Institute has made certain recommendations to reduce the cost of pencil slats and to reduce heavy rejections in finished material before use.

Owing to the limited supply of this timber, some other woods (a list of which is given in the pamphlet) will have to be used for cheap grade pencils. Attempts to soften and improve the whittling quality of second class woods so as to make them suitable for good quality pencils have not so far produced promising results. Further work is in progress.

Enquiries for supply of Baluchistan wood can be obtained from the Forest Officer, Baluchistan, Quetta.

PATCHOULI OIL

In a monograph entitled 'Oil of Patchouli' and published under the auspices of the Board of Scientific and Industrial Research of the Government of Mysore, Messrs. Subba Rao and Nagesa Rao have collected information regarding the origin, cultivation, yield, properties, chemistry, present position and future prospects of *Pogostemon Patchouli*, source of the powerfully odorous essential oil (Patchouli oil). The monograph is the second one published by the Mysore Government, the first one being devoted to Geranium oil, another essential oil of economic interest.

Patchouli leaves are said to have been introduced into England in the days of the East India Company and the oil was considered to be a good perfume. It is now considered as an indispensable and valuable

ingredient in different types of soap perfumery, perfumes and other cosmetics.

Pogostemon Patchouli, is cultivated principally in the Straits Settlements, Island of Penang, Singapore, and the Wellesley province. Cuttings imported from the federated Malay States were grown at Mysore, and a big plantation is likely to materialize soon.

IDENTIFICATION OF BURMA TIMBERS

THE Forest Research Institute, Dehra Dun, has published a pamphlet on "The Identification of Burma Commercial Timbers" (Indian Forest Records, (N.S.) Utilization, Vol. 3, No. 6, 1945). A previous bulletin on the subject, published by the Government of Burma in 1932, being not available owing to Japanese occupation, the present publication has been prepared to meet the demand during the reconstruction period.

It includes all the necessary information required for field identification and is, moreover, supplemented with drawings.

The given descriptions of different species and their photomicrographs will serve as a key for the identification of timbers.

Burma is noted for teak (*Tectona grandis*) which is her principal forest product as well as her main stay. In normal times Burma is responsible for World's supply of teak. Information concerning teak, padauk (*Pterocarpus macrocarpus*), and other utility timbers required for railway sleepers, beautiful decorative woods etc. may be had from this pamphlet which, when read along with "The Forests of Burma" (Burma Pamphlet 5, Longmans Green), will help all those who are interested in the reconstruction of Burma.

PLASTIC AND ENGINEERING MATERIALS

B. S. GIDVANI,

ACTING DIRECTOR, LONDON SHELLAC RESEARCH BUREAU

THE mechanical engineer generally interprets the term "strength of materials" as strength of metals. The malleability and ductility of the metals coupled with the fact that they can be "liquified" by means of heat provide easy methods of moulding them into any desired shape by simple die-casting. They have considerable durability and strength but modern methods and conditions demand modern materials. In this era of high speed machinery, the elimination of extraneous noise has become the concern of both engineers and other executives, for it has been long realized that the noise not only reduces the life of the plant but also affects the efficiency of the operators considerably. It is well known that the introduction of non-metallic gears and pinions etc. in the machinery will reduce the transmission noise to a minimum.

With the development of aeroplane and motor car, the engineer requires lightness of structure, and a high specific gravity of metals tends to become a serious handicap. The quest for a material possessing low weight, toughness, great permanence and easy moulding properties has resulted in many synthetic plastic materials. Many of these resins have a tensile strength as high as cast aluminium but are half as heavy. They can be worked into any intricate shape and design and to exact size by modern mass-production methods. They have properties which meet the requirements of the electrical, the automobile, the aeronautical and the mechanical engineers who have not been slow to make the most of these plastic materials.

Thermosetting plastics are of more interest to the engineer than the thermoplastic materials due to the interesting property of the former of softening initially under the influence of heat and then changing under continued application of heat into a permanently hard material which can not soften again on further heating. These withstand temperatures of 150°C above which they decompose. The chemical change which occurs during heat curing treatment also produces the useful properties of infusibility, insolubility in all common solvents and resistance to acids and weak alkalis.

Thermosetting materials alone by themselves are not sufficiently resistant to shock and exhibit a tendency towards hardness to the extent of being brittle and consequently have not found great use for mechanical purposes. With the incorporation of reinforcing materials, commonly known as "fillers" such as wood-flour, asbestos or paper pulp varying degrees of toughness, resiliency and shock-absorbing properties can be imparted to these resinoids.

For engineering purposes, these thermosetting resinoids may conveniently be sub-divided into two groups, namely, powder mouldings and laminate goods. The phenolic resin occupies the first place entering into the composition of approximately 75-80% of all the moulding powders while amino

resins take the next place of importance. The filler generally used is woodflour but impact strength is considerably increased by the use of fibrous fillers such as asbestos. The engineer receives these mouldings as either finished articles ready for use or as components ready for assembly.

Although for certain classes of work moulded cast resin bearings have been employed, laminated materials offer more scope to the mechanical engineer as they have much greater strength and toughness than the powder mouldings.

In the production of the laminated materials for engineering purposes, the resin is employed in the liquid form and the filler consists of either paper or textile sheets. The sheets are passed through a bath of the resin solution in some volatile solvent and after drying, the impregnated sheets are cut to size and pressed under heat and high pressure, to form composite solid boards. As previously mentioned under the influence of heat, the resin is converted into a permanently hard, infusible and insoluble material. Before this final hardening occurs, the resin is for a short time quite plastic which enables the laminations to be pressed into close-knitted boards and the final polymerisation of the resin gives them a permanent solidity.

Powder Mouldings

The electrical engineering industry largely uses these for their mechanical convenience and insulating properties. When large number of components of exactly the same size and shape are required for mass assembly of such articles as vacuum cleaners, radio receivers, meters or small weighing machines, the powder mouldings can rarely be excelled in accurate mouldings to exact size, appearance, wearing properties, low maintenance and above all low initial cost. The mouldings with asbestos and woodflour are sufficiently strong for light engineering work while those based on fabric or paper, costing slightly more, can be used in place of most small metallic castings. One of the best examples of the application of plastic mouldings of interest to the engineer is the moulded bearings containing graphite powder as filler for slow running shafts and where lubrication is either difficult or impossible. Other examples are met in the motor car industry where steering bearings and clutch thrust rings made from plastics are freely employed.

Laminated Plastics

These approach more nearly to the engineers' ideas of a structural material. In the table below figures are given which show them to be considerably stronger than the best powder mouldings.

TABLE I

Properties	Phenolic Mouldings						Other Mouldings	
	Powder Mouldings		Laminated Mouldings					
	Woodflour Filler	Fabric Filler	Paper Base	base	Asbestos cloth base	Fine Cloth base	Grey Cast iron	Aluminium 96% cast
Specific gravity ...	1·25—1·52	1·37—1·40	1·34—1·55	1·34—1·55	1·60—1·65	1·36 1·40	7·2	2·6
Specific volume cubic inches per lb. ...	22·2—18·2	20·2—19·8	20·7—17·8	20·7—17·8	17·3—16·8	20·5 —19·8	2·8	10·5
Tensile strength lbs. per sq. inch ...	6000—11000	6500—8000	6000—13000	8000—12000	9000—12000	8000—18000	20000—35000	1200—1600
Modulus of elasticity lbs. per sq. in. × 10^3 ...	10—15	7—12	5—20	15			60—150	80—120
Compression strength lbs. per sq. inch ...	16000—36000	20000—32000	20000—40000	20000—40000	18000—40000	30000—45000	70000—95000	10000—30000
Impact strength Izod, ft. lbs. per sq. inch	1—2	2—4	5—7 Face 2—3 Edge	20—40 Face 10—15 Edge		20—60 Face 10—40 Edge	0·5—1·5	2—12
% Elongation at break	0·5—1	0·5—1	1—2	1·5—4		1·5—4	0·25—1	3—10
Water absorption 24 hours immersion %	0·2—0·6	1·0—1·3	0·5—9·0	0·5—9·0	0·5			

It will be noticed from the table that the laminated fabric materials have a better impact strength than the cast iron or aluminium and a specific gravity of only 1·34-1·55 as compared with 7·2 of cast iron or 2·6 of aluminium. This considerable reduction in weight substantially offsets the somewhat lower tensile and cross breaking strengths of the laminated materials when compared to cast iron. It should, however, be noted that the tensile, the cross breaking and the compressive strengths of these materials is as high as that of aluminium.

Fabric laminated plastics are employed by the mechanical engineer in the manufacture of bearings, gears, pinions and many other industrial components. On the other hand, nearly all of the laminated materials used in the electrical industry, have a paper base. Although accurate mouldings of intricate design from laminated plastics can hardly be expected, it is possible to mould them into simple shapes such as rods and tubes of circular and square sections. The engineer generally receives them in the form of sheets, blocks, bars, rods, angles, channels ready for machining. Since laminated plastics are obtainable in such convenient forms, large structures can easily be built from them. Special moulds are not required and the cost of the machined parts of most of the patterns is not so high as in the case of powder mouldings.

Bearings made from the resinoids can be usually employed wherever bronze, white metal, lingum vitae etc. have previously been used. The application of the laminated resinoids for heavy duty bearings in roller mills and similar plants is now well-established. Some remarkable properties of such bearings are recorded below. These bearings are used exactly in the same manner as the metal ones, and cooling and lubrication is also carried out in the ordinary manner as with the metallic counterparts.

Specific Gravity ...	...1·3 - 1·4
Tensile Strength ...	...9000-12000 lbs/sq. inch
Brinell Hardness ...	.. 40
Compressive Strength at right angle	>40000 lbs.
Compressive Strength in direction of laminae	...>20000 lbs.
Water absorption, 24 hours immersion	0·6%
Coefficient of Friction with Water Lubrication ...	...0·015-0·02

Long run tests and practical applications of these bearings have proved that there is economy of 25-50 per cent in power consumption and that they have approximately 20-40 times longer life than the metal ones. The Rolling Mills Committee of the German Iron-masters Association in its report No. 136 gives an example of a rolling mill which when fitted with a laminated fabric bearing gave a production of 36,000 to 80,000 tons against an average of 2,400 tons with a bronze bearing. The same report states that, although, the cost of the resinoid bearing was 50 per cent higher than the bronze one, the latter worked out at 7·5 times the cost of the former due to the greater durability.

Other advantages which have been found for the resinoid bearings are cheaper operation costs as they can be run satisfactorily with only water as lubricant, lower maintenance charges, cleaner operations, elimination of excessive peak loads, longer runs between shut downs and cooler rolls. Loadings can be increased and heavier reductions made with consequential increase in production.

These bearings have also been successfully employed for very heavy duty work including trucks and another form of bearings with wider range of application is now being experimented with. The latter are self-lubricating and are manufactured as brushes or split-bearings having an excellent graphitic surface. Their properties are:

Specific Gravity	... 1·25—1·30
Tensile Strength	... 5500 lbs/sq. inch
Brinell Hardness	... approx. 29·5
Water absorption, 24 hours immersion	... 0·35%
Coefficient of friction (running dry)	... 0·08- 0·15

These bearings have good impact strength and stand well the shock of feeding and starting the machine. They are different from those well known small and fragile bushes made from moulding powders based on graphite as filler. Though manufactured to run dry they can be used with various liquids which do not corrode the shaft in humid atmosphere. Their properties made them highly suitable for medium speed conveyors and similar plants. They can also be used as gland rings or employed in conjunction with glands, thus making designing easy and simple, by avoiding complicated assemblies and so affecting a great deal of economy by dispensing with the more expensive alloys.

Laminated materials used for the bearings have, however, their limitations and high temperature is the limiting factor when they are fabricated from a laminated material having cotton fabric base. A temperature of 150°C. is the maximum for such materials as charring takes place when subjected to continuous use above this limiting temperature and the smooth bearing surface is altogether destroyed.

Resinoid materials have a low thermal conductivity which throws the task of the removal of heat produced by friction, on the lubricant or on the conduction through the metal shaft. This is really not so great a disability as may appear at first sight. For example it has been found that with a resinoid bearing fitted to rubber milling rolls, the conduction of process heat to the frame work of the rolls is greatly reduced, and thus small but effective economy is obtained without any detriment of the bearing.

For many drives it is neither necessary nor economical to have the gears cut to precision limits or made from materials having very high tensile strength. In such cases, laminated resinoids can advantageously replace the metals.

The power capacity of the plastic materials is comparable with that of cast iron. Owing to its low specific gravity, higher peripheral velocities can be used. Velocities upto 7,500 feet per minute are possible where good bearings with rigid mountings are employed but for ordinary purposes, 3,000 feet per minute should be considered a maximum. The natural resilience of the plastics enables them to withstand shock loads and absorb any effects due to inaccuracies in commercial gear cuttings.

Recently more attention has been paid to the reduction if not the complete elimination of the high-pitched metallic noise usually associated with metal drives, especially the high speed ones. By substituting the resinoid fabric bearings, considerable relief is obtained.

Principal advantages claimed for gears made from the laminated materials are great toughness, higher pitch line speed, lower weight, silent operations, resistance to water, oil, steam, acids, weak alkalis and heat upto 150°C., high stability under all kinds of atmospheric conditions and excellent wearing properties.

They are largely used as electric motor pinions from fractional horse power to 300 H.-P. at all speeds. Motor cars are usually equipped with camshafts, speedometers and wind screen wiper gears made from these resinoids and small wheels for electric clocks, carpet sweepers and meters are turned out in great quantities.

Screw Threads

For this purpose laminated resinoids with a paper base are generally employed. They machine smoothly and take fine threads. Canvas base rolled and moulded rods are largely used as bolts, although the material at first seems course and the lamination in the worst direction for the prevention of thread stripping. In fact, using Whitworth standard threads and numbers of threads per nut, no stripping is observed and the rod breaks at the bottom of the thread.

Laminated rods screwed by mass-production methods on a capstan lathe, fitted with mild steel nuts and pulled without special regard to alignment and flat seating, have given tests on ⅝ inch diameter of 1,100 lbs. equal to 5,500 lbs. per square inch for paper base and for canvas base 1,700 lbs. equivalent to 8,500 lbs. per square inch.

Chemical Plants

Due to corrosive action of acids and solvents used in chemical plants, the pumps and pipe lines often give a lot of trouble. The plastic materials offer seamless pipe lines both rigid and flexible which are unaffected by age, have excellent impact strength and can be bent and welded together very easily like ordinary metal pipes. Plastic materials are also available for mouldings that are resistant to chemicals like alcohol, acetone, petrol, benzene, lubricants, fatty acids and bleaching solutions. Pipes made from these laminated resinoids have been successfully employed for conveying dry chlorine gas. Plastics are also obtainable for moulding pump-housings and flanges which have all the desired properties of metal counterparts but are resistant to all sorts of chemicals excepting strong oxidising agents and strong alkalis.

MEDICINE AND PUBLIC HEALTH

CORD TRANSFUSIONS IN NEW BORN INFANTS

The *American Journal of Obstetrics and Gynecology*, July, 1944, has a paper by H. W. Mayes, which reports the results of cord transfusions in new born infants. The results appear to indicate that cord transfusions may be the means of saving premature babies, of benefiting full term infants when the delivery has endangered life, and of treating the blood dyscrasias.

The reported 34 cases of cord transfusions included 18 infants weighing less than 5½ lbs. with gestation from 23 to 30 weeks, and 16 infants weighing 5½ lbs. and over, 13 full term, and 3 with gestation of 36 weeks or under. Citrated mother's blood was used in most cases; father's or blood donor's blood from the bank, the investigator points out, may also serve as a substitute. A little less than 10 c.c. per pound of baby weight is usually sufficient. The blood to be transfused is kept ready before the infant is born. A 50 c.c. syringe containing 5 c.c. of a 2 per cent solution of sodium citrate is employed to withdraw blood from

the mother, or from the father or the donor, if for any reason blood from the mother is not desirable. In case filtered blood is to be used it should be carefully filtered through several layers of gauze before being administered. Transfusion should be effected very slowly, say 30 or 40 c.c. in about 5 minutes. The umbilical vein offers a convenient avenue by which new-born infants may be transfused with adult blood.

Of the 34 infants receiving cord transfusion, four died, three in the smaller weight group and one in the larger. The general conclusion is that premature infants and particularly those usually considered nonviable are definitely benefited. In mothers giving a history of previous still-births or of hemorrhagic disease and suspected of erythroblastosis, cord transfusion may be attempted with advantage. A small transfusion of 20 c.c. of mother's blood acts as a direct stimulation to the respiratory centre and tends to overcome any tendency toward hemorrhage in infants suffering from difficult delivery.

MILK IN INDIA

The adoption of an improved technique for increasing the production of milk in the country was discussed at the second meeting of the policy committee on Agriculture, Forests and Fisheries in April last at New Delhi.

Steps to encourage the development of cattle breeding and dairying on proper lines to increase the production of milk would be taken up by the Government. It was suggested that the Imperial Dairy Research Institute should be re-organized and expanded, and a number of sub-stations established, and that an Indian Central Milk Committee would have to be created to co-ordinate their activities.

Provincial and State Governments should maintain an adequate staff for developing the dairy industry and for helping to increase milk production by setting up district cattle breeding and dairy farms which would breed pedigree bulls and high yielding cows and buffaloes. They should also arrange for production and supply of green fodder and concentrates.

In his memorandum "On the Technological Possibilities of Agricultural Development in India", Dr Burns has shown that the production of milk can be increased by 75 per cent in India: (1) 30 per cent by feeding, (2) 15 per cent by breeding, (3) 15 per cent by management, and (4) 15 per cent by control of diseases. There is no reason why, with proper cooperation among the Central, Provincial and State Governments, the targets as fixed should not be reached.

For some decades Bengal has faced a real physical shortage of milk. In normal living, the per capita availability of milk (including milk products) is estimated to be 2·8 oz. per day, whereas the minimum requirements are 15 oz. for adults, as suggested by Dr N. C. Wright in 1937, and 20·25 oz. for babies of six months to six years, as suggested by the Indian Research Fund Association ("Feeding of Children from six months to six years in war time").

In normal times the annual milk production in Bengal was estimated at 429·39 lakh maunds, whereas Bengal's annual requirement as estimated from the census of 1941 amounts to 2708·30 lakh maunds. Hence import of cattle from other provinces is an immediate necessity as a short-term measure.

Speaking at a meeting of the Royal Asiatic Society of Bengal, Dr L. C. Sikka, Special Officer, Agriculture Department, Bengal, discussed the problem of Calcutta's milk position and urged improvement in supply and distribution of milk in the city. Calcutta has now a population of 27·7 million, of which 23·1 million were adults and the rest were children below 12. This estimate did not take into account the large number of persons living in clubs, hotels and other residential institutions.

According to Dr Aykroyd, each adult should get half a pound and a child and a nursing mother one pound of milk each per day. This represents a much lower requirement compared to Western standards. Calculated on this basis, Calcutta needs a milk supply of 20,000 maunds per day with another 1,100 maunds for clubs, boarding houses, hospitals etc. The same quantity is used for the manufacture of sweets, milk powder etc; the total requirement, therefore comes-up to 22,200 maunds a day. The minimum requirement for the "priority classes", including infants, nursing mothers and invalids is, however, estimated at about 11,000 maunds. The daily supply of milk now stands at only 3,700 maunds, much lower than 1937 figures when the supply was 6,000 maunds. Of the 3,700 maunds, 1400 maunds were taken away by manufacturers of sweets etc., and the balance 2,300 maunds were available for 27·7 million ration card holders, making available less than 1 oz. of milk per head per day.

According to Dr Sikka, the control of milk trade in all its aspects viz., production, processing, and distribution is to be entrusted to a milk council consisting of official and non-official organizations. We strongly emphasize the need for the immediate formation of such a council in Calcutta and Bengal to solve immediately "the milk famine", specially for the priorty classes, and urge upon the authorities to take up the breeding of indigenous cows and the cultivation of fodder as a solution of the chronic milk shortage.

CHEMOTHERAPY IN AMOEBIASIS

T. N. GHOSH,

BENGAL IMMUNITY RESEARCH LABORATORY, CALCUTTA

THREE diseases—malaria, amoebic dysentery and bacillary dysentery—are three of the most important of the tropical diseases. Their ravages sometime extend far beyond the tropics.

Amoebic dysentery is caused by a protozoal organism (*Entamoeba histolytica*), which settles down in the large intestine, producing ulceration of the gut-wall. The parasite can occur in two forms: the active form and the resting or cystic form. The free active forms are present in acute infections, but in chronic dysentery few free forms are present and most of the parasites occur in the cystic form. It is found that the cystic forms are much more resistant to the action of drugs than are the free forms, and chronic cases are the chief carriers of the disease and are often very difficult to disinfect.

There are two problems in the treatment of intestinal amoebiasis—firstly, the relief of acute infection and, secondly, the prevention of relapses and the cure of chronic infections. An outstanding contribution to the chemotherapy of amoebiasis has come from the group of workers- Leake, Reed, Anderson, Chopra, Knowles and others. It is from their critical studies that not only facts in regard to the present drugs but also possibilities of developing new and better ones are obtained. No one drug is known to-day to be completely effective. Moreover, there is need to vary the treatment in regard to the individual patient as well as to the type or degree of severity of the infection.

Treatment of Acute Cases

The injection of emetine hydrochloride usually produces a rapid and complete cure of acute cases of amoebic dysentery. It is the only known eminently satisfactory preparation for the treatment of amoebic hepatitis and amoebic liver abscess. Emetine, however, has a depressant action on the heart muscle and may produce cardiac irregularity. Emetine ($C_{29}H_{40}O_4N_2$) is obtained from Ipecacuanha root, available largely in Brazil. Pyman and his co-workers analysed the Brazilian variety and obtained 2·7 per cent total alkaloid (emetine 1·35 per cent, cephaeline 0·25 per cent, the rest being a mixture of other alkaloids). It appears that the Indian variety of Ipecacuanha root is as good as the Brazilian variety, so far as its emetine content is concerned. The researches of Pyman and others have shown that emetine is a complex *iso*-quinoline derivative, the constitution of which has been settled. Cephaeline ($C_{28}H_{38}O_4N_2$) is emetine in which one of the four methoxy groups is replaced by a hydroxyl group. The commercial preparation of emetine from cephaeline by methylation shall be of considerable importance, because emetine commands a much higher price than cephaeline.

In the course of extensive researches to find an amoebicidal drug better than emetine, Pyman and his co-workers synthesised a series of compounds of the general formula, $RR^1N-(CH_2)_x-N.R.^1R$. Of these, the most active were two compounds (I, R, R^1=*n*-amyl, $_x$=10; II, R, R^1=*n*-butyl, $_x$=10). The first of these in acid medium was five times more potent than emetine, whereas in alkaline medium it was less so. Furthermore, it was less toxic to mice both orally and subcutaneously. Clinical trials, however, proved it to be less effective than emetine for the treatment of amoebic infections.

Kurchi bark is used in India as a remedy for dysentery. During the last few years much interest has been displayed in the Indian species of Kurchi bark and besides Conessine, 15 other alkaloids have been isolated, although it should be noted that doubts have been expressed by several authors as to the individuality of a number of substances included in this list of alkaloids. Brown found the total alkaloid to be as toxic to free-living amoebae as emetine. Chopra tried clinically the total alkaloids in the treatment of acute cases by intramuscular injections and found them as powerful as emetine in their immediate effect on the symptoms as well as in their curative value. They did not, however, produce any of the general toxic effects usually met with when emetine injections were given, especially for prolonged periods. However, these injections produced inflammation and swelling of the parts and were accompanied by considerable pain in some cases. According to Knowles and his co-workers, intramuscular injection of Conessine has not produced promising results in the treatment of amoebic dysentery. In view of these findings, investigations should be carried out to ascertain (*a*) whether Kurchi bark contains any other alkaloid, besides the sixteen already isolated, (*b*) whether the therapeutic activity of Kurchi bark is due to one particular alkaloid present, or due to the combined effect of some or all of these alkaloids.

Treatment of Chronic and Relapsing Cases

The treatment of chronic and relapsing cases is much more difficult than the acute cases. Emetine

injection which constitutes the best known remedy for acute cases is generally a failure in the chronic state of the disease. This difficulty stimulated the discovery of other drugs for the treatment of chronic and relapsing cases of amoebic dysentery. Emetine bismuth iodide, Kurchi bismuth iodide, Carbarsone, Stovarsol, Yatren and Vioform have been produced and put in the market. There is much divergence of opinion regarding the efficacy of each individual drug. According to many clinicians, no single drug of this series can always eradicate the chronic infection and it is necessary to combine a number of drugs in an endeavour to obtain sterilisation. Even then, there is no combination of drugs which provides a guaranteed cure and there is much need to discover more potent drugs.

The action of emetine injection is not understood. It is thought that it attacks the tissue invaders and therefore, it must be complemented by another drug to destroy the lumen dwellers. Sometimes there is unwarranted tendency to use emetine injection to the limit of tolerance and to repeat the procedure unduly. After the acute symptoms have been brought under control by the judicious dosage of emetine injection, the final sterilisation should be attempted by the concerted use, over a period, of a variety of drugs among which Carbarsone or Vioform by mouth combined with Yatren retention enema has been considered by many clinicians as giving the best results.

Emetine Bismuth Iodide.—It is a complex iodide of emetine and bismuth, and is administered orally. In the intestine it is decomposed by alkali and the emetine that is set free, exerts its action in the intestine. In the treatment of chronic cases, some clinicians have obtained very favourable results with this in England. According to Knowles, the drug is not so successful with the class of cases usually met with in India.

Auremetine.—It is a combination of the periodides of emetine and auramine. It is said to have given some gratifying results in the treatment of chronic cases. Its toxicity is low and does not generally cause nausea or vomiting.

Kurchi Bismuth Iodide.—It is a complex iodide of bismuth and the total alkaloid of kurchi. In the chronic cases where a high concentration of the drug in the intestine is desired, the oral use of kurchi bismuth iodide, a compound chemically and therapeutically analogous to emetine bismuth iodide, was recommended by Acton and Chopra in 1929.

Carbarsone.—Chemically, it is *para*-carbamidophenylarsonic acid, which can be prepared from atoxyl. It was first prepared by Ehrlich, but he discarded it on account of its being one of the pentavalent compounds, a group which he then regarded as inferior to the trivalent arsenicals. It was subsequently found to possess pronounced amoebicidal properties and was introduced by Anderson and Reed in 1931 as a highly specific drug for the treatment of amoebiasis. According to Reed and his co-workers and also Leake, Carbarsone is more effective and less toxic than Stovarsol. As with other arsenical compounds of this type, the possibility of optic trouble should be borne in mind, although there is practically no evidence that this has occurred.

Stovarsol.—Chemically, it is 3-acetylamino-4-hydroxyphenyl-arsonic acid. It was introduced by Fourneau and Levaditi in 1922. It is also used, though to a very limited extent, for the treatment of chronic amoebic dysentery.

Recently Sandground in America has obtained conclusive evidence, on the basis of some animal experiments, that *para*-aminobenzoic acid has no inhibitory action on the trypanocidal potency of Carbarsone and Stovarsol. On the other hand, *para*-aminobenzoic acid exerts a detoxication action against massive doses of these organo-arsenical drugs. If confirmed on clinical trials, this work is going to have far-reaching importance in the administration of organo-arsenical drugs.

Iodoform.—The use of iodoform for treatment of amoebic colitis was advocated by Castellani in 1935. However, its use for the treatment of amoebic dysentery has been abandoned in view of the discovery of better substitutes.

Yatren.—Chemically, it contains the sodium salt of 7-iodo-8-hydroxy-quinoline-5-sulphonic acid, and can be prepared from 8-hydroxy-quinoline. In 1921 Mühlens and Menk advocated the use of this drug for the treatment of amoebic dysentery. It possesses well-marked amoebicidal properties and appears to be effective both in acute and chronic cases. It is specially indicated in those patients who suffer from pathological conditions of the liver and the kidney and in certain forms of dermatitis, where carbarsone is contraindicated. When given orally, it has a troublesome feature, as it often produces diarrhoea, though mild and painless, which starts on the second or third day of treatment and persists till the treatment is over. Knowles and his co-workers are of the opinion that unless diarrhoea is produced, the results of treatment are poor. In fact, according to them, the drug acts by producing irritation of the mucous membrane of the colon. This drug is, therefore, now generally used as retention enema.

Vioform.—It is 7-iodo-5-chloro-8-hydroxy-quinoline. It also possesses pronounced amoebicidal properties and it is reported to be effective in acute and chronic cases. It is a safe drug, because the margin between its therapeutic dose and toxic dose is very great. It is especially useful in cardiac cases, in which emetine is contraindicated. The drug,

however, should not be administered continuously for 2 or 3 weeks. A rest period for a week or so should be allowed in order to avoid any chance of iodism. According to David, Johnstone, Reed and Leake (1933), Vioform seems more satisfactory than Yatren in amoebicidal activity and in the need of a smaller dosage at less cost. It seems slightly less satisfactory than Carbarsone in that it appears more apt to cause gastrointestinal irritation and lacks the definite tonic and stimulating action of Carbarsone. Where Carbarsone is contraindicated, Vioform seems to fill an important place in the treatment of amoebic dysentery.

Brucea Sumatrana.—The seeds of ya tan tzu, a plant well known in South China and Malaya, have been used since a long time in the treatment of chronic amoebic dysentery.. It is known botanically as *Brucea Sumatrana* and its properties have been investigated by Power and Lees in 1905 and also by Hsiao-Liang in 1937. An alkaloid brucamarine and a bitter glucoside have been isolated from the seeds. According to Hsiao-Liang, treatment of acute or chronic cases with the seeds produced beneficial results. Detailed work on the chemistry and pharmacology of the active principle of these seeds may prove useful.

Conclusion

Chronic amoebiasis, always a difficult condition to treat, is frequently encountered by medical practitioners in the tropics. It devitalizes the patient considerably and renders him susceptible to other infections.

An analysis of the present status of chemotherapy in amoebiasis indicates that marked progress has been made in the past 25 years in the development of some relatively specific drugs which are rather well tolerated by the patient. However, as a result of extensive clinical trials of most of the important chemotherapeutic drugs, described above, on cases of amoebic dysentery in the army in India, Leishman and Kelsall have recently found that there are some relapsing cases which resist the action of all these drugs or a combination of some of them. They have felt the urgent need for the discovery of a new, more potent amoebicidal drug which will effect cure in chronic and relapsing cases. There is, therefore, abundant need to explore other preparations, whether by any synthetic process or even from any natural source.

In conclusion, it may be stated that besides chemotherapy the nutritional state of the patient in amoebiasis is another important factor in increasing his resistance to the pathogenic organism. The vitamins as well as the essential amino-acids may help him in withstanding the undesirable effects often associated with this disease and in its usual clinical treatment.

BOOK REVIEWS

Penicillin.— Published by the United States Office of War Information, 1944.

The United States Office of War Information has done a great service to the medical profession by publishing a reprint of 28 papers (1943-44) on penicillin (case observations) from the *Journal of the American Medical Association*, the bulletin of the *New York Academy of Medicine*, the *Medical Times* and *Science*. The contents are classified on subjects dealing with a general discussion of penicillin, and penicillin as applied to specific illnesses and to venereal diseases.

The therapeutic development of penicillin is recent and wartime, and ideas about it are still vague. Comprehensive information about the culture and extraction of the drug, dosage and mode of administration can be profitably utilized from this brochure by the physician at a time when the drug is being made available for civilians. The distribution of the drug in India, as our readers are aware, is now under the control of the Central Penicillin Control Board.

Valuable work on penicillin is still in progress in the laboratories in Britain and the U. S. A. and also at the Haffkine Institute at Bombay and the Bose Institute at Calcutta. Processes are being evolved for the manufacture of penicillin on a commercial scale in India.

Penicillin can be effectively used in all staphylococcic infections (carbuncles, meningitis, pneumonia), all cases of clostridial infections (gas gangrene, malignant edema), all hemolytic streptococcic infections (cellulitis, peurperal sepsis, peritonitis), all anerobic streptococcic and pneumoccic infections, all cases of sulphonamide resistant pneumococcic pneumonia, all gonococcic infections, and in all cases of sulphonamide resistant gonorrhoea.

Penicillin as an efficacious remedy for bacillary infections (typhoid, dysentery, coli), tuberculosis, influenza, rheumatic fever, malaria, etc. is not as yet established. This new mycologic and chemotherapeutic agent promises to replace sulphonamides in medical practice when adequate supplies are available.

The brochure is, however, incomplete, as the results of investigations on penicillin, extensively carried on in Britain and elsewhere where the drug has been used for treating war wounds etc., are not included.

A. K. G.

Beautiful Flowers of Kashmir.—By Ethelbert Blatter, Vol. I. Published by Staples and Staples Limited, London. Pp. xv+198; plates 34, figures 193.

Published for the first time in 1927 by John Bale, Sons and Danielson Ltd., a reprint of this book appears for the second time after a gap of nearly two decades by Messrs. Staples and Staples, Limited, London. Following Bentham and Hooker's system of classification, this volume includes the beautiful flowers of Kashmir, from the Ranunculaceae to Compositae. A key for the identification of species is given under each genus and the excellent plates will help the botanist as well as the ordinary layman to easily identify the flowering plants of Kashmir.

The work was originally commenced by Prof. F. Hallberg, after whose untimely death in 1924, it devolved on the present author. As originally intended, Father Blatter has succeeded in his efforts to make the book popular avoiding technical terms as far as possible.

The book is not intended to give an account of the complete flora of Kashmir but Collett's *Flora Simlensis*, Coventry's *Wild Flowers of Kashmir*, and Koul's *Beautiful valleys of Kashmir*, when consulted along with this book, will give a fairly complete account of the Botany and Natural History of one of the finest botanical areas in the world. Anyone wishing to trek in the Kashmir mountains, will find this book very useful.

It is unfortunate, however, that Hypericaceae, erroneously inserted in p. 55 in the original edition, is not corrected in this reprint.

A. K. G.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

A NOTE ON THE CRYSTALLINE CONSTITUENTS OF 'KAKRA-SRINGI'

'KAKRA-SRINGI', or the gall-like excrescences caused by a kind of insect on the leaves and petioles of *Pistacia integerrima* Stewart (N.O. *Anacardiaceae*), has been the subject matter of an investigation by Chopra and Ghosh[1] who isolated *inter alia* a crystalline compound (m.p. 140°), which they thought to be a hydrocarbon. The present author investigated the nature of this compound in 1937. In view of the fact that Karimullah and others[2] have recently taken up the investigation of *Kakra-Sringi*, it is desired to place on record the results obtained before.

The crystalline compound of Chopra and Ghosh was isolated by extracting the coarsely powdered and dried galls with benzene (b.p. 60-70°). Removal of the solvent left a pale greenish yellow syrup, which on long standing deposited colourless crystals. These were purified by repeated crystallisations from alcohol and melted at 146-170°, the m.p. being not sharp. Slow crystallisation from methyl alcohol of the crude material, which appeared to be a mixture, gave two types of crystals: (*i*) soft, brittle, needle-shaped and (*ii*) hard, transparent, rhombic. These were mechanically separated and repeatedly crystallised from the same solvent when the needle-shaped crystals melted at 174-75° and the rhombic crystals at 153-4°. Repeated crystallisations from benzene and petroleum ether, chloroform and methyl alcohol and acetone, benzene and methyl alcohol eventually raised the m.p.'s to 179-80° (shrinking at 177°) and 161-62° (shrinking at 155°).

Both these compounds were acidic to litmus and dissolved in aqueous sodium bicarbonate with effervescence. These were consequently called α-acid and

β-acid respectively. Their behaviour towards some reagents are recorded below:

Reagent	Alpha-Acid (m.p. 179-80°)	Beta-Acid (m.p. 161-62°)
Alcoholic Alkali (hot or cold)	Soluble, no change of colour	,,
Alkaline sodium nitroprusside	No change of colour	,,
Conc. Sulphuric Acid	Red	Red
Ferric Chloride	Yellow colour	,,
Ammoniacal $AgNO_3$	No reduction	,,
Fehling's solution	,, ,,	,,
Calcium chloride	No. ppt.	,,
Lead acetate	,, ,,	,,
Conc. H_2SO_4+a drop of acetic anhydride.	Orange-red colour with a slight green fluorescence	,,
Conc. H_2SO_4+ $CHCl_3$	Pink ring at the junction of two liquids; on shaking H_2SO_4 layer becomes pink and then orange. Finally a slight green fluorescence appears. $CHCl_3$ layer remains colourless.	,,

The analytical data of the acids were as follows:—

α-Acid	β-Acid
C—79·66, 79·68, 79·97	79·96, 80·0, 80·3, 80·21
H—10·0, 9·9, 9·24	9·9, 10·0, 10·05, 10·22
Optical rotation +17·31°	−78·15°
M.W. (Cryoscopic in benzene) 727·8	727·8
Equivalent wt. (titration against N/20-alkali) 395·2	404·7

The methyl esters, prepared from *each* of the acids by saturating a methyl alcoholic solution with dry hydrochloric acid at 0°C formed colourless needles from methyl alcohol and had the same m.p. of 108-9°. A mixture of the two also melted at the same temperature. [Found: C=80·2, H=10·5, M.W. (cryoscopic in benzene) 428·3].

The preliminary data as recorded above may be interpreted thus:

(1) The acids have molecular weights above 400.

(2) The C-H values are in fair agreement with the molecular formula $C_{30}H_{44}O_3$.

(3) The acids are presumed to belong to the group of triterpenoid carboxylic acids of C_{30}-type which are widely distributed in vegetable kingdom.

(4) In benzene solution the molecules are associated.

I am indebted to Dr P. K. Bose for his guidance and helpful suggestions.

SANAT KUMAR GHOSE

Chemistry Department,
University College of Science, Calcutta.
1-5-1945.

[1] Chopra and Ghosh, *Ind. J. Med. Res.*, *17*, 377, 1929.
[2] Karimullah and others, *J. Sci. Ind. Res.*, *3*, 423, 1945.

NOTE ON THE ORIGIN OF THE ASBESTOS DEPOSITS OF MANPUR, DHALBHUM SUB-DIVISION, SINGHBHUM DISTRICT, BIHAR

THE basic and ultrabasic rocks which extend southwards and south-eastwards from near Manpur, about three miles south of the Chaibasa-Ghatsila road and about eight miles from Haludpukur railway station on the Tatanagar-Gorumahisani line, contain very good quality and workable deposits of asbestos.

The origin and mode of occurrence of the deposits have not been studied so far. The asbestos is of the chrysotile variety and the fibres range in width from thin stringers to unusually long logs some of which are six feet long. There is considerable variation in the degree of fiberization and these grade into masses of light greenish logs of scaly serpentine. A little calcite and small egg shaped nodules of asbestos fibres containing pyrites in their cores are also found. The rocks immediately adjoining the asbestos are greenish altered basic and ultrabasic rocks but talc schists and talc-chlorite schists are common. Talc-chlorite schists are also found near about the other asbestos deposits in this part of Dhalbhum such as Butgora. The rocks show considerable shearing and even the veins of asbestos are sheared. The occurrence of the peculiar egg shaped nodules also point to the same direction.

The parent rocks vary from dark black peridotites showing beautiful mesh-structure olivine, hypersthene, augite, iron ores, etc., to gabbros through troctolite. The gabbro shows sharp boundary against the peridotite. Serpentinisation has not affected the rocks uniformly and consequently the distribution of asbestos is irregular. Massive and comparatively little altered peridotite is seen passing into a serpentine rock containing veins of asbestos.

The striking feature of the deposits is its association with hydrothermally altered and sheared schistose rocks. It appears that the area had undergone regional metamorphism, but while the massive and compact peridotites escaped with slight metamorphism which gave it a little gneissose appearance, the more hydrothermally altered rocks have become schistose with some amount of shearing owing to the presence of such minerals as talc, chlorite, etc. Hand specimens containing cross-fibre veins of asbestos show that the shearing was subsequent to serpentinisation.

The outcrops of the basic and ultrabasic rocks form inconspicuous masses in the midst of granite. The age relation between the peridotite-gabbro rocks and the granite is doubtful. The granite rocks also vary considerably in texture and structure. Future study will show whether the granite rocks are of the same age or of different ages. Dykes of a gneissose granite were found cutting through the gabbro but as they are far from the asbestos deposits it appears that the formation of asbestos, or serpentinisation, is unconnected with the granites of the area. The asbestos seems to have been a direct result of hypohydrous alteration[1] of the olivine rich rocks and is earlier than the formation of talc and chlorite.

The detailed account of the rocks and the deposits will be published elsewhere later on. Thanks are due to Rai Sahib M. C. Rungta and to Mr K. Chakravarty, the Manager of the mines.

S. C. CHATTERJEE

Calcutta, 5-6-1945.

[1] The Problem of Serpentinisation and the origin of certain Chrysotile Asbestos Talc and Soapstone deposits by H. H. Hess, *Economic Geology*, *28*, 655, 1933.

IDENTIFICATION OF EGGS OF COMMON FRESHWATER FISHES OF BENGAL

THE collection of eggs of edible fresh-water fishes is generally done in lots. Unless we are definite about their identity it may lead to utter disappointment at the end. Identification of eggs depends mainly on nature, size, shape and colour which we have found in working out a scheme of I.C.A.R. The following table will be of some use in this direction.

Nature of the egg	Size	Shape	Colour	Particular species
1. Non-floating				
(A) Non-adhesive ...	(1) 5·3 to 6·5 mm.	round	light red	*Catla catla*
	(2) 5·5 mm.	,,	brownish	*Cirrhina mrigala*
	(3) 5 mm.	,,	reddish	*Labeo rohita*
	(4) 3—4 mm.	,,	bluish	*Labeo calbasu*
	(5) 4·5 mm.	,,	bluish	*Labeo gonius*
(B) Adhesive				
(*a*) Non-filamentous	(1) 1·5 × 1·3 mm.	oval	greenish	*Clarias batrachus*
	(2) 1·2 to 1·5 mm.	round	yellowish	*Wallagonia attu*
	(3) 3·5 mm.	,,	,,	*Notopterus notopterus*
	(4) 6·5 mm.	,,	,,	*Notopterus chitala*
	(5) 2 mm.	,,	light brown	*Mastecumbelus sp.*
	(6) 1 mm.	,,	transparent	*Barbus conchonius*
(*b*) Filamentous	(1) 1 mm.	round with both short and long filaments		*Oryzias melastigma*
	(2) 1·4 mm.	round with long filaments		*Aplochilus panchax*
2. Floating	(1) 1 mm.	round	golden amber	*Ophicephalus punctatus*
	(2) 1·25 to 1·5 mm.	,,	amber	*Ophicephalus striatus*
	(3) 1·5 × 1·7 mm.	oval	amber	*Ophicephalus marulius*
	(4) ·7 mm.	round	transparent	*Anabas testudineus*
	(5) ·75 mm.	,,	,,	*Colisa fasciata*
	(6) ·7 mm.	,,	,,	*Colisa lalius*

Zoology Department,
Calcutta University,
Calcutta, 1-5-1945.

H. K. MOOKERJEE

SCIENCE AND CULTURE

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THE 220th ANNIVERSARY OF THE U. S. S. R. ACADEMY OF SCIENCES

THE celebration of the 220th anniversary of the Foundation of the U. S. S. R. Academy of Sciences, which took place at Moscow and Leningrad from June 15 to June 30, is a memorable event in the annals of science. It was the first occasion after nearly six years of World War that the scientists of the world were given an opportunity of coming together and discussing scientific problems in a friendly atmosphere. It was the first occasion that the immense potentialities of air-travel in shortening the time of travel, and thus facilitating international communication was realized in civil life. The English delegates, twenty one in number, and the French, and the Belgians left their respective countries after breakfast, and could reach Moscow before dinner time. The American delegates, 17 in number, took longer time (nearly four days), as they chose purposely a circuitous route and had to change their planes at Cairo and Teheran. The journey from India, made by Drs M. N. Saha and Joseph Needham, took eight days, because they had to change and wait at the two intermediate stations of Paghdad and Teheran. Actually the shortest distance from Calcutta to Moscow is only 2800 miles and can be covered by a fast bomber flying without stoppage in 14 hours and with stoppage and in easy stages, in two days, if the route Calcutta -Delhi-Cabul-Taskent-Moscow were open. It is thus possible with modern air transport, and provided the pass-port regulations are made easier, to get up an international conference in course of two or three days. But human psyche has still to undergo a radical purification before the enormous power of science can be switched on to do good instead of evil.

The 220th session of the U. S. S. R. Academy did not differ in essential respects from the sessions of similar bodies in other countries *e.g.*, the meetings of the British Association, or the American Association for Advancement of Science, or our own Indian Science Congress. There was the usual reception of delegates, address by the President of the Academy (President Komarov who is an eminent Botanist, now in his seventyfifth year), sectional meetings and discussions, visits to research institutes of the Academy, and to other places of interest *viz.*, the Kremlin Palace, museums, collective and State farms, the Lenin Library, and the Moscow Volga Canal, the ruins of the Pulkova observatory and the suburbs of Leningrad, the Peterhof and Tsarskoe Selo palaces. But in place of addresses by sectional presidents on their respective subjects, we had reports by leading Academicians on the progress of their respective fields of study in Russia. One should not omit the dinners which were on an enormous scale and the various entertainments provided every evening in the form of operas, ballets, concerts, etc. etc.

The foreign visitor must have gathered that the U.S.S.R. Academy of Sciences is in many respects a fundamentally different institution than others bearing a similar or cognate name in other countries *e.g.*, the Royal Society of London, or the National Academy of Sciences of the U.S.A., though its origin and its activity during the pre-Revolution days were quite similar to those of its sister bodies in other countries.

The Academy was conceived by Peter the Great, the maker of European Russia, as part of his grand scheme of moulding Russia on the model of the European State, but he died (Jan. 1725) before he could formally found it, though he approved of the statutes before his death. The Academy was brought into existence the same year in December at St. Petersburg under the name of *Academie Imperiale des Sciences de Saint Petersburg* or, in Russian, *Imperatoskaya Academiya Naük* by his widow and successor, the Empress Catherine I, who fixed an income of about £5,000 for the payment of 15 Academicians and the clerical staff. The 'Academicians' were ex-

pected to devote their whole life to the pursuit of science and knowledge.

President Komarov differentiates a number of stages or periods in the development of the Academy:

"The First Period which covered the eighteenth century, was a period of struggle for a scientific outlook. In all the diversified fields, where the members of the Academy were active, they fought for a rational interpretation of facts. The human mind freed from the scholastic way of reasoning, characteristic of the Middle Age, refused to acknowledge the supremacy of any other authority. In the domain of natural science this tendency at that time expressed itself in a mechanical interpretation of Nature.

The Second Period covered the nineteenth century, and early part of the twentieth century before the Revolution of 1918. This was a period of individual achievement by great scientists all over the world, as a result of personal initiative. As a result, an immense store of information in every domain was accumulated, and in bourgeois countries, led to what is known as the Industrial Revolution.

During the second period, science in Russia was not confined within the Academy, but spread to the universities, and Russian science could boast of such names as Mendeleev, the discoverer of the Periodic Classification, Metchnikov, the physiologist and discoverer of white corpuscles, Chebichev, the mathematician, Karpinsky and Vernadsky, geologists, Pavlov, physiologist, and others too numerous to mention. But there was no 'Industrial Revolution' in Russia, due to the stupidity of Tsarist rule, and Russia continued to be a country of peasants and serfs dominated by capitalists, mostly foreign. This led to the tragic end of Tsarist Russia in the first World War. The scientists of Russia were aware of the backward condition of their country, and Mendeleev in particular did sometimes give vent to his feelings of dissatisfaction, but they had no effect on the *Tsar and his advisers*.

The Third or Modern Period commenced after the Revolution of 1918, and is characterized by Komarov as follows:

"If we describe the XVIII century as a century of reason, the XIX century as a century of science, then our times may be described as a universal penetration of Science into the life of Man."

According to Komarov, Lenin, inspired by the writings of Marx and Engels, was the first and almost the solitary figure amongst the rulers of the world, to have realized clearly the great role which science was destined to play in the drama of human history. He realized that Tsarist Russia was, even on a very moderate estimate, hundred years behind her time as regards her economic and industrial development, and he foresaw that if the young Soviet Republic was to survive amidst world of enemies, she was to jump off these hundred years by a forced march in course of ten or fifteen years. This was the origin of the State Planning Commission, established in 1921, which became the mainspring of Russian economic life for nearly quarter of a century now.

As a link in this gigantic task of reconstruction of Soviet Russia, Lenin called the Academy to its aid, and enormously expanded its activities. The result of this move may be easily gathered from the following figures:

In 1917, the Academy had 40 academicians, employed 212 scientists and technicians, had 5 laboratories, 5 museums, 1 research institute, 2 observatories under its control and organized 15 commissions. The budget was one and half million roubles.

In 1941, the Academy had 76 scientific research institutes under its control, of which 47 were central, 20 under branches of the Academy, 11 independent laboratories, 42 seismological, biological and other stations, and 6 observatories, and employed 5000 scientists and technicians. An account of the Research Institutes under its control appears elsewhere in this issue. Its budget in 1941 was 135 million roubles, plus 31 millions alloted from republican and local budgets for the maintenance of the various branches of the Academy. There is a little difficulty in understanding what a 'rouble' actually means in foreign currency, but taking the rate of exchange as granted to employees of the British embassy, the amount comes up to $3\frac{1}{2}$ million pounds *i.e.*, nearly 4 crores of rupees. If we take the rate available in Russian banks (20 roubles to the pound) it comes to ten crores of rupees.

It must not be supposed, however, that the Academy monopolizes all scientific research. In Soviet Russia, there are no private industrialists, merchants and landlords; all heavy industries, public health, transport, land reclamation, river control etc. are State monopolies and are under the People's Commissars. Every one of the industries and subjects has research institutes of its own, and every big factory which are of course all State-owned has research laboratories of their own. With a view to promoting medical research, the Council of People's Commissars has decided to found an Academy of Medical Sciences of U.S.S.R. attached to the Commissariat of Health of U.S.S.R. Excluding medical research, the total state budgetary provision for all scientific research was a little over one thousand million roubles in 1938. It must be much larger now.

The principal function of the Academy of Sciences is to promote the general development of both theoretical and applied sciences in the U.S.S.R., study and development of the achievements of world science. The Academy bases its work on the

planned utilization of scientific achievements for the purpose of promoting the building up of a new socialist classless society.

In the words of Peter Kapitza:

"The Academy of Sciences is the G. H. Q. of Soviet Science. It is called upon to be the ideological guide of the whole of Soviet Science, from top to bottom, and to direct it along a healthy channel. Each individual institute of the Academy of Sciences must follow the same policy, *i.e.* strive to become the guiding influence in its particular sphere of science and try to achieve its maximum development."

President Komarov dwells upon some of the achievements of the Academy in individual fields.

"The third period has seen the discovery of superfluidity in helium by Kapitza; our chemists are proud of the theory of physical-chemical analysis developed by Kurnakov, of the works of Zelinsky, Favorsky and others. Remarkable biochemical ideas have been developed by Bach. Mechanics and mathematics have received valuable contributions at the hands of Krylov and Vinogradov. The study of the Earth's crust has been substantially advanced by the investigations of Obruchev. In physiology important work has been done by the pupils of Pavlov headed by Orbeli."

"The power of the Academy of Sciences of the U. S. S. R. as the scientific centre of the Union became conspicuous during this great national war with the German invaders. With the country, with the whole body of scientists, the Academy put all its strength in the defense of Fatherland and had substantially contributed to the defeat of the enemy."

A feature characterizing the development of science during the third period is that the 'complex' method was used in working out scientific problems. As an example of such 'complex' way of treatment, the President refers to the work of the Committee on the Mobilization of the Urals' resources of which he has been the head in the following words:

"This Committee has worked out the most urgent methods to be undertaken in ferrous and non-ferrous metallurgy, power engineering, transport, manufacture of building materials, and agriculture. During the 50 years that I have been working as a scientist I have never felt so completely satisfied as since I have been given the opportunity to work at the mobilization of the inexhaustible resources of this great Country of ours. Never have I seen our scientists to work with such enthusiasm. All fields of Soviet science have been involved. The physicists were occupied with the theoretical and exeprimental work aimed at the construction of new types of armament, mathematicians have worked out new rapid methods of calculation for artillery, aircraft and men-of-war; chemists have developed new processes for producing explosives, alloys, pharmaceutical substances; biologists discovered additional food-resources for the Red Army and the population; and many thousands of lives of our Red Army men so precious to us have been preserved, thanks to the new methods of war medicine worked out by our scientists. We feel proud of the idea that our work has been helpful in to the army and the navy, which have given so good an account of the enemy."

This short account will probably convey to the mind of the reader some idea of the organization, and the working of the U.S.S.R. Academy of Sciences. As a society of learned men devoted to the pursuit of science it had a long and glorious record in the annals of world science; and whilst still retaining all the characteristics of a learned society, it has been entrusted with a very important role in national defence and economy, and have been given ample powers, and finance to carry out its new responsibilities. In the new Russia, the senior men of science have thus been admitted into the inner Council chamber for the purpose of shaping and directing national policy, and are not kept in the out house, as in this country, like the poor relations of rich men by politicians and civil servants even in matters where knowledge of science is essential.

APPENDIX I

Scientific Research in Russia outside the Academy

In addition to the work done in the Institutes under the Academy, U. S. S. R. has the following research organizations.

Research Institutes under People's Commissariats. (Research Institutes are attached to the various *People's Commissariats* (Government Departments or Ministries), both to the All-Union Commissariats (such as those of Foreign Trade, Railways, the Oil Industry, etc., which are directly responsible to the Central Government), and to the Union Republican Commissariats (such as those of the Food Industry, Textile Industry, Public Health, etc., which exist in each of the 16 Republics of the Union, the 16 Commissariats covering a given subject, being themselves co-ordinated by a corresponding body in Moscow).

In accordance with the distribution of Commissariats provided for in the Constitution of the U.S.S.R. the scientific research institutes under the various *People's Commissariats* are also divided into All-Union-Republican institutions.

Among the All-Union Commissariats which have research institutes under them are the Commissariats of Foreign Trade, Railways, Post, Telegraph and Telephones, Maritime Fleet, River Fleet; Industries of Coal-Mining, Oil, Electric Power Stations, Electrical Engineering, Iron and Steel, Non-Ferrous Metals, Chemical, Aircraft, Shipbuilding, Munitions, Armaments, Heavy Machine-Building, Medium Machine-Building, General Machine-Building, Navy, Agricultural Stocks, Civil Engineering.

Among the Union-Republican People's Commissariats which have research institutes under them are the People's Commissariats of Food, Fishing, Meat and Dairy Products, Light Machineries, Textiles, Timber, Agriculture, State Grain and Live-stock Farms, Finance, Trade, Internal Affairs, Justice, Public Health, Building Materials, Education, Local Industry, Municipal Economy, Social Maintenance, Motor Transport, Foreign Affairs and Defence.

The Research Institutes under Universities.—The Research institutes, which form component parts of *universities* in the U.S.S.R., carry out extremely diverse scientific work both in the university institutes and laboratories and in the special departments and scientific circles, libraries and societies in

which the student body and the University teaching staffs are united and which are characteristic of regular educational institutions and also of correspondence courses.

Whereas in 1917 Russia had only 91 universities and colleges and 280 research institutes, employing 4,340 scientists, in 1939 the U.S.S.R. had 700 universities and colleges ; and 908 research institutes staffed with 26,246 scientists.

In the universities and colleges of the U.S.S.R. science is organized on the principle of the direct and lively participation of the professorial staff and of the regular and post-graduate students in the investigation of the vital problems of science and engineering.

More than 800 subjects are being investigated in the institutes and laboratories by the staff members of the *Moscow University*, for instance. Since the war the University has solved many problems of vital military and economic importance.

The Institute of Mathematics of the Moscow University is continuing to work on the qualitative theory of differential equations, topology, the theory of probability and others.

The results of the work done by the *Institute of Mechanics* of the Moscow University on the elastic-plastic deformation of metal are being widely applied in the designing bureaux of industrial research institutes.

Registering devices called "time magnifiers" and "radium clocks" have been invented in the astronomical instruments laboratory organized in the *Institute of Astronomy* of the Moscow University since the war.

Associates of the *Institute of Chemistry* of the Moscow State University have devised a method of producing frost resisting caoutchouc. This method will be widely used in practice.

The department of the dynamics of the development of organisms in the *Institute of Zoology* of the Moscow University is doing interesting work on animal fecundity.

The fruitful work of the Moscow University has received high recognition from the Soviet Government in 1945 ; eleven professors were awarded Stalin prizes for their work.

In 1944, the university arranged to publish several volumes of scientific notes on "The Role of Russian Science and Culture in world Science and Culture". The most prominent scientists in all the faculties of the University are contributing to this series. The publication will reflect the development of Russian science and culture in the years of peaceful construction and in the war of the Soviet Union against Nazism.

The role of the Russian nation in the development of world science and culture was discussed at a big conference organized by the University in June, 1944.

Since the war the humanitarian faculties of several institutes—philological, philosophical, law and economic were merged with the University.

The inflow of students in 1943 was so great that the University could not admit all the applicants. The 1,700 who were accepted were those who had the best results in the entrance examinations. The faculty of international relations for instance, had only 200 vacancies, while more than 2,000 applications were submitted.

The great interest which Soviet youth is showing in history, culture and art, and, in particular, in the culture of the Western and Southern Slavs, has made it necessary to extend the programmes of study. Courses in *Slav philology* are now being offered by two departments instead of one: the department of Slav literature and Slav philology. An eastern department has been opened with courses in Iranian and Turki philology. The *historical faculty* has enlarged its course in the history of the U. S. A. and England. A scientific section has been organized in this faculty to study unpublished archives. At its meetings the section hears reports on the history of the political and cultural relations between Russia, the U. S. A., and Great Britain.

The students of the *physics faculty* are becoming acquainted with the latest achievements of Soviet Science in two new departments of the Moscow University—under Academician P. Kapitza, who gives a course in the physics of low temperatures, and under Professor V. V. Shuleikin, corresponding member of the Academy of Sciences of the U. S. S. R., who is giving a course in the physics of the liquid envelope of the earth.

The hero-city of *Leningrad* is proud of its *university*. The scientific personnel of the *Leningrad university*, which has been decorated with an order by the government, has displayed an exceptionally high patriotic spirit and creative initiative. Neither hunger, nor cold, nor furious air raids, nor artillery bombardment could break the will and the spirit of this heroic body of people. Even in the most trying months of the siege the scientific workers of the University continued their educational and practical scientific work. It suffices to note that until the middle of 1942, that is, until their evacuation to Saratov, the associates of the University solved more than 70 vital practical scientific problems. Many of them are of vital importance to defence, as, for instance, Professor Ambartsumian's work on photometry, Academician Fock's work on improving firing accuracy and the work of the bio-chemical department on combating gas gangrene in wounds.

Research work under Scientific Societies.— Research work (likewise the mass propaganda of science among the citizens of the U. S. S. R.) is also carried on in the *scientific societies* of the U.S.S.R. in their scientific institutes and sections. Thus, for instance, the Moscow Society of Naturalists, founded in 1805, had the following scientific sections in 1940: zoology, botany, geology, hydrobiochemistry, geography, biophysics, paleontology, histology and experimental morphology, and conducted as it still does to-day in war time, considerable research work and popularizing work.

Medical Research in the U.S.S.R. has not been dealt with under the above headings, and will be treated separately.

APPENDIX II

Rules of Election of Members, Honorary Members and Corresponding Members

Whenever there is a vacancy in the list of members of the Academy a notification to that effect is published in the official government newspaper, the "Izvestia".

In the course of two months from the date of publication, scientific institutions, public organizations and individual scientists or groups of scientists may submit to the Academy of Sciences in writing (and accompanied by an exposition of their reasons for doing so) the names of candidates for membership from among outstanding scientists specializing in the indicated subject. The names submitted to the Academy of Sciences are made public through the press.

The list of candidates and the testimonials submitted by institutions, organizations and private individuals are read out at a meeting of the particular department of the Academy that is concerned, after which the meeting proceeds to elect candidates by secret ballot, not less than two-thirds of the votes being required. At the next meeting of the General Assembly of the Academy the names of the candidates chosen by the department are announced and the Assembly proceeds to elect members of the Academy from among this list by secret ballot, a simple majority of votes being sufficient for election.

The candidates for honorary membership are nominated by the departments of the Academy. The elections are held by the General Assembly of the Academy by ballot, a majority of at least two-thirds being required.

Corresponding Members

Outstanding scientists in various fields of knowledge may be elected corresponding members. Corresponding members who are doing permanent work in the Academy are included on its staff.

Notification of vacancies is published two months before the date set for the election of corresponding members. All scientific institutions, public organizations and private individuals have the right to submit their nominations to the Academy of Sciences (backed up by written reasons). The nominations are considered and the election of candidates is held in the particular departments concerned, a ⅔ majority vote being necessary for election. The corresponding members elected by the departments are confirmed by the General Assembly of the Academy of Sciences by a simple majority vote.

No less than ⅔ of all the members of the Academy of Sciences must be present at the election of members and honorary members and the confirmation of corresponding members of the Academy of Sciences of the U. S. S. R.

Structure of the Academy of Sciences

The *structure* of the Academy of Sciences of the U.S.S.R. may be presented as follows:—

1. The General Assembly of the Academy of Sciences of the U.S.S.R.
2. The Präsidium of the Academy of Sciences of the U.S.S.R.
3. The Divisions of the Academy of Sciences of the U.S.S.R.
4. The Institutes of the Academy of Sciences of the U.S.S.R.
5. The branches and bases of the Academy of Sciences of the U.S.S.R.

General Assembly of the Academy of Sciences of the U.S.S.R. The highest ruling body of the Academy of Sciences is the *General Assembly*, which consists of all the members and honorary members of the Academy of Sciences.

(*a*) The General Assembly determines the general line of scientific work to be done by the Academy and its component parts and settles the principal organizational problems. It hears the reports of the branches and the institutions of the Academy and of its individual members, discusses problems of a scientific, technical and scientific-social nature, elects honorary members, regular members, the Council of the Academy, and confirms the corresponding members of the Academy.

The various departments hear scientific reports and suggestions and exercise control over the scientific activities of the institutes under them. The work of each department is directed by a bureau headed by the Academician-Secretary of the department. The departmental bureaux call meetings of their departments whenever these are considered necessary.

The meetings of the General Assembly and the departments are held in the form of sessions. Meetings of the General Assembly and the various departments are called whenever it is necessary to discuss current scientific and organizational questions.

Every year the General Assembly of the Academy of Sciences hears and confirms the annual report of the Präsidium of the Academy.

The right to vote is accorded:

(*i*) in the general assembly: to the honorary members and regular members of the Academy of Sciences;

(*ii*) in the departments: to honorary members, regular members of the Academy of Sciences and the corresponding members of the given department, also the directors of the various institutes of the Academy of Sciences when the question under discussion concerns the work of the institution under their charge. Only honorary and regular members of the Academy may vote in the election of new members to the Academy of Sciences.

At meetings of the departments and the General Assembly the corresponding members and heads of various institutions of the Academy have a consultative vote on all questions.

At the meetings of the Academy of Sciences all questions except those concerning the election of regular members, honorary members and corresponding members are decided by a simple majority vote.

(*b*) The General Assembly of the Academy of Sciences of the U. S. S. R. has the following institutions under it:

(*i*) *The Council for the Study of Productive Forces.*

(*ii*) *The Editorial and Publishing Council.*

(*iii*) *The Publishing House of the Academy of Sciences*, which publishes books, journals and other materials dealing with the activities of the Academy.

The Council for the Study of Productive Forces organizes the study of the natural resources and productive forces of the country. This Council organizes expeditions to study the natural resources and productive forces of the various republics, territories, and regions and directs these expeditions with the institutes, branches and bases of the Academy and other research organizations serving as bases. The Council calls conferences for investigating the natural resources of the country, generalizes the investigations of the productive forces of the country and promotes the practical utilization of their results.

The chairman and the members of the Council for the study of the Productive Forces are elected by the General Assembly of the Academy of Sciences for a term of three years.

The *Präsidium of the Academy of Sciences of the U.S.S.R.* The *Präsidium* (or what we call the Council) carries out the decisions of the General Assembly and in the intervals between the meetings of the General Assembly is the highest executive body of the Academy of Sciences. The Präsidium reports on the important decisions it has adopted at the next meeting of the General Assembly.

The Präsidium considers and endorses the plans of work of the various institutions of the Academy of Sciences and hears their reports, considers and decides scientific organizational questions, draws up the annual budget estimate of the Academy of Sciences, administers the Academy's credits, controls the expenditure of funds, maintains connections between the Academy of Sciences and all government and public institutions, directs the publishing activities of the Academy and convenes sessions and meetings of the General Assembly of the Academy of Sciences.

The Präsidium of the Academy of Sciences consists of a president, three vice-presidents, eight Academician-Secretaries of departments and five Academician-members.

The President of the Academy of Sciences and also the first, second and third vice-Presidents are elected by the General Assembly for a term of five years from among the members of the Academy of Sciences.

The Academician-Secretaries of the departments of the Academy of Sciences are elected by the departments concerned from among the members of the Academy of Sciences for a term of three years and are confirmed by the General Assembly.

The Academician-members of the Präsidium are entrusted by the Präsidium of the Academy with the direction of definite sectors of work and are elected for a term of three years.

The business manager of the Academy of Sciences is appointed by the Präsidium of the Academy and takes part in the meetings of the Präsidium where he has the right of a consultative vote.

The Präsidium of the Academy of Sciences appoints an administrative secretary. The secretary of the Präsidium takes part in the meetings of the Präsidium and has the right of a consultative vote.

In an article appearing elsewhere in this issue, the various Divisions of the Academy and the Scientific Institutes under them have been discussed in detail.

The branches and bases of the Academy of Sciences are also entrusted with important work; we shall not, however, make any attempt to discuss these organizations.

INSTITUTIONS UNDER THE U. S. S. R. ACADEMY OF SCIENCES

M. N. SAHA and S. N. SEN

THE institutions* of the Academy of Sciences are the most important research organizations responsible for much of the scientific work, both fundamental and applied, carried out in the whole of the U.S.S.R. The main task of these institutions, as defined in the Statutes of the Academy of Sciences, consists:

"in the extensive development of Soviet science he different fields of knowledge, in the study and extens utilization of the achievements of advanced scient fic thought with the aim of developing the productive for of the U. S. S. R., raising the cultural level of the work people and completing the building of a classless society

The supreme role assigned to these institutions in the conduct and direction of scientific research in the whole of the Union, with special reference to the all-round development of the country's resources and the material well-being of the people, is made abundantly clear from this brief statement of functions. We shall first give an account of the various institutions and then discuss the ways in which these functions are fulfilled, the structure and administration of the institutes, financial aspects and other allied topics.

Some of the institutes can be traced from older beginnings; but most have come into existence since the Revolution. Whenever any problem of national importance arises, first a committee is formed consisting of best available authorities on the subject; next stage is a laboratory which may be in an independent building or may be located, as a temporary measure, in an already existing institute. The final stage is an institute with a full director who is solely responsible for the institute's work.

The "Commissions" are bodies with wider powers, and with wider geographical range. They are entrusted also with survey and field work.

The Academy of Sciences is divided into eight Divisions. These Divisions concern the following branches of science and knowledge:

(1) Physico-Mathematical Sciences,
(2) Chemical Sciences,
(3) Geologo-Geographical Sciences,
(4) Biological Sciences,
(5) Technical Sciences,
(6) History and Philosophy,
(7) Economics and Law,
(8) Literature and Philology.

Each Division has a Bureau of its own; its personnel consists of Academicians and corresponding members, with an Academician secretary as the executive head. The secretary is ex-officio a member of the Supreme Präsidium of the U.S.S.R.

* Based on a memorandum prepared by the Society for Cultural Relations with the U.S.S.R.

Academy and Research Institutions

The research institutions, of which a detailed description will appear in what follows, comprise scientific institutes, laboratories, commissions, research stations, societies, etc. If it is not otherwise mentioned, the seat of the laboratory is at Moscow. The name of the Director is given opposite each institute.

Physico-Mathematical Sciences

The *Division of Physico-Mathematical Sciences* (Secretary: Joffe) includes the following institutions:

The P. N Lebedev Physical Institute, (Vavilov); reorganized in 1934 from an older institute of long standing.

The Physico-Technical Institute at Leningrad, (Joffe); founded in 1918.

The Institute of Physical Problems, (Kapitza); founded in 1934.

The V. A. Steklov Institute of Mathematics, (Vinogradov); reorganized in 1934 from an older institute (1921).

The Seismological Institute and its stations, (Bontskovsky); founded in 1928.

Astrophysical Commission, (Ambarzumian); founded in 1943.

The Astronomical Observatory at Pulkova, (Neujmin); dating from 1839.

The Institute of Crystallography, (Shubnikov); reorganized in 1944 from laboratory stage in 1937.

Commission on Spectroscopy, (Landsberg); founded in 1940.

The Committee on Meteorites, (Fesenkov); founded in 1921.

The Astronomical Council, (Michailov); founded in 1937.

The Council of Radio-physics and Radio-engineering, (Papalexi); founded in 1938.

The Commission on Acoustics, (Andreev); founded in 1936.

The Commission on Cosmic Rays, (Alikhanov); founded in 1944.

Institute of Geodetical Astronomy at Leningrad, (Subbotin); founded in 1920, reorganized in 1939.

Institute of Theoretical Geophysics, (Schmidt) ; founded in 1937.

Hydrophysical Laboratory, (Shuleikin) ; founded in 1942 from older origin in 1929.

Before 1918 there were only three research institutes in physics under the Academy *viz.*, the Institute of Physics and Biophysics under Lazarev, the Physico-technical and Rontgenological Institute at Leningrad under Joffe, and the Optical Institute at Leningrad under Rozdestvensky. But these were interested more or less in pure research and avoided undertaking research in the application of the results of fundamental investigations to medicine, industry and to the solution of technical problems. In contrast to pre-revolutionary laboratories, each of these institutions has now combined pure with applied research. Thus, physics is combined with research in technical problems in the first institute, physics with medicine in the second, and with optics and the production of optical glass in the third institute.

The process of merging physics with technical problems made still further progress during the third Five-Year Plan. The Optical Institute became the leading institute of the optical industry and now employs nearly 5000 operatives and manufactures most of the optical instruments needed for Russia. The Physico-Technical Institute (Joffe) is closely associated with the production of solid rectifiers. The Institute of Physics of the Academy of Sciences introduced the spectral analysis of metals in factories (Mandelstam). The Institute of Physical Problems (Kapitza) and in some measure also the Ukrainian Physico-Technical Institute became the centres for the production of liquid oxygen and low temperatures.

The Physico-Technical Institute, during the first Five-Year Plan from 1929-1933, rendered a very important service in uniting local scientific cadres and in founding physico-technical institutes in Tomsk, Kharkov, Dniepropetrosk and Sverdlovsk (Urals). The Institute of Physics, originally in Leningrad, which in the past produced such eminent men as Lenz, discoverer of the law of Electro-magnetic Induction, Jacobi, Prince Gallitzin, the seismologist and others, was transferred to Moscow, where it merged with the Moscow school of physicists led by L. I. Mandelstam. It was named after Lebedev, once its director who was the first to measure pressure of light. This Institute has now become one of the leading physical institutes in the U.S.S.R. The Ukranian Academy of Sciences has set up an Institute of Physics in Kiev, which has developed apace in recent years.

The Institute of Physical Problems, created by the Academy of Sciences for P. L. Kapitza, deserves more than a passing notice. Under the capable direction of this distinguished Soviet physicist who spent a number of years as director of the Mond Low Temperature Research Laboratory at Cambridge, it has developed into an outstanding institute, where problems of liquefaction and production of low temperature are studied with remarkable thoroughness. Some of the recent investigations carried out here include the discovery of the phenomenon of superfluidity and the development of new types of machines for the liquefaction of oxygen and helium.

The most fundamental problems of modern experimental and theoretical physics now form important part of the programme of research followed in the physical institutes. Atomic nucleus and cosmic ray laboratories were opened in the Physics and Radium Institutes (under the Division of Chemical Sciences) of the Academy. For purposes of such investigations, these laboratories have undertaken the construction of high voltage generators and cyclotrons.

The post revolutionary period thus witnessed a phenomenal development of physical sciences as well as of every other science in the U.S.S.R.

Chemical Sciences

The *Division of Chemical Sciences* (Secretary, A. N. Bach) is responsible for all chemical investigations with which the Academy is credited and includes the following institutes:

The Institute of Organic Chemistry, (Nesmeyanov) ; founded in 1934.

The Kurnakov Institute of General & Inorganic Chemistry, (Cherniyaev) ; existing since 1748, reorganized in 1919 and in 1934.

The Institute of Colloid Electro-chemistry, (Frumkin) ; founded in 1930.

The Institute of Hydro-chemistry, (Kashinsky) ; founded in 1914.

The Vernadsky Laboratory of Geo-chemical Problems, (Vinogradov) ; from laboratory stage in 1920 to institute stage in 1943.

The Radium Institute at Leningrad, (Khlopin) ; founded in 1922.

The Institute of Chemical Physics, (Semenev) ; from the laboratory stage in 1921 to institute stage in 1931, now transferred to Moscow.

The Commission of Analytical Chemistry, (Vinogradov) ; founded in 1940.

The Commission on Isotopes, (Khlopin) ; founded in 1939.

The Commission of Mineral Waters.

The D. I. Mendeleev Chemical Society of the U.S.S.R. (formerly called the Russian Chemical Society) ; founded in 1868.

The foundation of modern chemical researches in the Soviet Union was laid in the nineteenth century by the great trio of Russian chemists—Zinin, Butlerov and Mendeleev, whose names are remembered with great veneration and pride by all students of chemistry in Russia. N. N. Zinin (1812-1880) was a chemist and teacher at the Kazan University, and in his younger days worked at Liebig's Laboratory. He produced aniline from nitrobenzene, a transformation of unique importance, which not only earned him a permanent place in world science, but ushered in a new era in synthetic dyestuff industry. Butlerov was the celebrated pupil of Zinin and made his mark by originally developing the idea of chemical constitution and the structure theory. During his time St. Petersburg (University), where he taught and worked hummed with his disciples working on various problems and led Russia in the field of chemical research, as did Kazan at the time of Zinin. As for Mendeleev, he will leave in the memory of mankind as long as science lasts.

The Revolution has given a new direction to chemical research in the U.S.S.R. Previously scientific work used to be conducted in small laboratories of the universities in few large cities. Many of these laboratories have now developed into big research institutes and have formed part of the organization of the U.S.S.R. Academy of Sciences.

The Institutes of Organic and of General and Inorganic Chemistry have developed from the small laboratories of Favorsky and Zelinsky and of Kurnakov and Chugayev respectively. The N. N. Semenev Institute of Chemical Physics, now a separate institute under the Division of Chemical Science, was formerly a part of the Physico-technical Institute at Leningrad. The Radium Institute has now assumed the role of a central institute for the conduct of all researches pertaining to radio-activity. The Bio-geo-chemical Laboratory, formerly under the direction of Academician V. I. Vernadsky, concentrates on the study of bio-chemical life of the earth's crust.

Mendeleev Chemical Society, organized in 1868 by the then foremost chemists of Russia, is now one of the leading learned societies in U.S.S.R. Academician A. N. Bach, well-known for his work on synthetic rubber, is the present president of the Society. The Society had its presidents always elected from among the most distinguished chemists and had Zinin and Mendeleev as its past presidents. The Society preserves, studies and furthers the rich heritage left by Mendeleev and other chemists, popularizes the achievements of chemistry and introduces them in the national economy of the U.S.S.R. Even during the war, the work of the Society has continued unabated ; it has heard at its meetings about 800 papers and has given some 2,000 scientific and technical consultations.

Great as these chemical institutions are, greater still have been the achievements of Soviet chemists during the past few decades. Physico-chemical researches, that is work on border-line problems between physics and chemistry, have made considerable headway, thanks to the schools of Semenev and Frumkin, Terenin and Kondratiev, Roginsky and Syrkin. In his report before 220th Anniversary meeting of the Academy of Sciences, Academician N. D. Zelinsky gave an interesting account of the recent advances in organic chemistry in Russia. Dr Zelinsky has himself built up an extensive school of research workers in chemistry at the Moscow University and has further organized the Laboratory of Super-High Pressures where interchanges of organic compounds are studied under pressure without the influence of a catalyst. Some of the famous organic chemists he referred to include J. K. Fritzche (indigo derivatives), F. F. Beilstein (chemical nature of hydro-carbons in the Caucasian petroleum and the author of now well-known reference books on organic chemistry), M. A. Iljinsky (an authority in the chemistry of anthraquinone), S. V. Lebedev (well-known worker on synthetic rubber), A. E. Arbusov (organic compounds of phosphorus), A. E. Poray-Koshitz (aniline dyestuff), V. M. Rodionov (chemistry of the acomatic series), and others.

The Soviet chemists have not exhausted themselves within the four walls of the laboratory ; they have been instrumental in organizing a number of heavy and light chemical industries such as did not exist during the Tsarist regime. The optical glass industry (Grebenshhikov), the synthetic rubber industry (Lebedev, Favorsky , the plastics products industry (Ushakov), fertilizer industry (Britzke, Wolkovich), the aniline dyes industry (Poray-Koshitz), pharmaceutical, sulphuric acid, aluminium and magnesium, rare elements, radio-active elements (Khlopin), and pure reagents industries are some of the newly created chemical industries in U.S.S.R.

Geological & Geographical Sciences

The *Division of Geological and Geographical Sciences* (Secretary : Obruchev) includes :

Institute of Geological Sciences, (A. E. Fersman, former director and well-known for his work on the survey of mineral resources of U.S.S.R., is just dead and has been succeeded by D. S. Beliankin).

The Karpinsky Geological Museum, (Krizanovsky) ; reorganized in 1937 from very old beginnings.

Institute of Theoretical Geophysics, (Schmidt) ; transferred to the Physico-Mathematical Division.

The Obruchev Institute of Eternal Frost, (V. A. Obruchev) ; reorganized in 1936 and in 1939.

Institute of Geography, (Grigorev) ; founded in 1918, reorganized in 1931.

The Dokuchayev Institute of Soil Science, (Dokuchayev) ; founded in 1925.

Laboratory for Hydrogeological Problems, (Savarensky) ; founded in 1944.

The Oceanological Laboratory, (Shirshov) ; founded in 1941.

The Volcanological Station in Kamchkatka, (Zavaritsky) ; founded in 1944.

The Lake Laboratory at Leningrad with Station at Lake Baikal, (Nalivkin) ; founded in 1928.

Commission on Aerophotographic Surveying, (Stelanov) ; reorganized in 1944 from an old beginning.

The Oceanographic Commission at Leningrad, (Komarov) ; founded in 1927.

The Pacific Ocean Commission.

The Quaternary Period Commission.

The development of the geological and geographical sciences in Russia, like many other progressive work, owes its inception to Peter I who was deeply interested in the geology and geography of the vast expanse of the Russian territory. The first expedition to the Kamchkatka (1725), under the command of the Danish Seaman Bering, discoverer of the straits separating Asia from N. America, was organized at his instance to confirm the existence of a strait reported by the Cossack Dejner as far back as 1648. He requisitioned the services of De l'Isle, French geographer and astronomer, to carry out a cartographical survey of Russia, in which the great mathematician Euler assisted. In 1739, a Division of Geography was added to the Academy of Sciences, which compiled and published the first scientific atlas of Russia.

The interest thus stimulated by Peter I in geological and geographical investigations was more or less uniformly maintained. Particular mention may be made of the work of Michael Lomonosov who was responsible for organizing the first polar expedition to Spitzbergen with the object of discovering a route to India through the Polar Ocean. His many works on geology, mineralogy, metallurgy etc., bear testimony to his advanced views in geology. During the 18th and the 19th centuries, several expeditions were organized by the Academy throughout the length and breadth of Russia, and these led to significant advances in the exploration of the Caucasus, of the coasts of the Black and the Caspian seas, of the Altai and Near-Baikal regions, and of Northern and North-Eastern Siberia, inclusive of the Kamchatka Peninsula. Among the geologists who flourished towards the latter half of the 19th century appear such names as Koksharov, famous for mineralogical and crystallographical researches, Brandt and Fr. Schmidt, remarkable for their palaeontological studies, Karpinsky (1846-1936) noted for his first tectonic map of the European part of Russia and Vernadsky, the celebrated mineralogist.

In fact, the work of A. K. Karpinsky marked the beginning of a new era in Russian geology. Besides compiling the tectonic map, he carried on important work in palaeontology, stratigraphy, tectonics etc. and investigated the mineral resources of the Urals. Vernadsky specialized in the study of radio-active elements, mineralogy and geo-chemistry, and reorganized the Mineralogical Museum of the Academy of Sciences.

The progress in geological and geographical sciences has been the most spectacular in the period following the Revolution. In his report to the 220th Anniversary Meeting of the U.S.S.R. Academy of Sciences, the Academician V. A. Obruchev remarks that *'the achievements made by the Academy of Sciences in the domain of geological and geographical sciences within the twenty-seven years that elapsed since the October Revolution outbalance those of the nearly bicentenary period that preceded the Revolution'*. Several institutes, laboratories and committees were founded, and large numbers of geologists were trained to staff these institutions and take part in expeditions that were organized in hundreds. The Division of Geological and Geographical Sciences was organized as a new department in 1930.

All geological investigations are now shared between the Committee for Geological Research under the Council of People's Commissars and the Academy of Sciences. The former now concentrates its activities mainly on the survey of the country, whereas the Academy organizes expeditions to such regions where problems of stratigraphy, tectonics, petrography, and mineral distribution could not be studied for lack of data. The study of geomorphology, deposits of minerals, pedological problems, excavation of fossil mammals etc. form part of the programme of these expeditions by the Academy.

To carry out these investigations the Academy has established branch organizations and stations in

such far-flung parts of the country as the Kola Peninsula, in the Far East, and in the Soviet Socialist Republics of Kazakhstan, Georgia, Azerbaidjan, Armenia, Turkmenistan, Uzbekistan and Tadjikistan. Geological exploration in the Kola Peninsula has resulted in the discovery of apatite, nepheline, copper-nickel, titanium and iron ores, as also of some rare earths like niobium, tantalum, etc. Academician A. E. Fersman, late Director of the Institute of Geological Sciences, headed many of these explorations and organized a new large scale industry to exploit these new deposits of important minerals. Fersman led another important expedition to study the deposits of graphite, asbestos and mica in the East Sayan.

The Institutes of Geography and Soil science have carried out extensive work in geomorphology, soil science, and hydrology. Processes of salting and swamping of irrigated grounds have received investigation at the Institute for the Soil Science and some of the Central Asiatic branches of the Academy, and preventive measures have been successfully worked out.

The Volcanological Station at Kamchkatka arose out of an expedition organized by the Academy during 1934-37 to study the activity of the volcanoes in the Kamchkatka Peninsula. Loewinsin-Lessing and later Zavaritsky, the present Director of the Station, organized these expeditions and collected much valuable volcanological data. The volcano Avacha was personally investigated by Zavaritsky.

The Lake Laboratory at Leningrad and the Station at Lake Baikal are interested in problems concerning hydrology, chemistry, thermics, flora, fauna and ice-cover of these lakes. The Station has organized explorations of Lake Paikal and its coasts and has collected abundant information of great theoretical and practical importance regarding the genesis of the lake depression and its peculiar fauna, stratigraphy, tectonics and mineralogy of the region. Mention may also be made of the extensive research in geology, hydrogeology and permanent freezing in the region of the Amur River.

Biological Sciences

The *Division of Biological Sciences* (Secretary: Orbelli) includes:

The Komarov Botanical Institute of Leningrad, (Shishkin); finally organized in 1931 from older institutions going back to 1713.

The Timiryazev Institute of Plant Physiology, (A. N. Bach); founded in 1934 from an older institute dating from 1890.

The Bach Institute of Biochemistry, (Bach); founded in 1935.

Institute of Microbiology, (Isachenko); founded in 1935 from older institute dating from 1929.

Institute of Genetics, (Lysenko); reorganized in 1933 from an institute dating from 1921.

Institute of Forestry, (Sukachev); founded in 1944.

Institute of Cytology, Histology, Embryology, (Zavarzin); reorganized in 1938, founded in 1919.

Institute of Zoology at Leningrad, (E. N. Pavlovsky); reorganized in 1931 from the Zoological Museum dating from 1767.

The Severtshov Institute of Evolutionary Morphology, (Smalgauzen); founded in 1936.

Paleontological Institute, (Vologdin); founded in 1930.

The Pavlov Physiological Institute at Leningrad, (Orbelli); reorganized in 1936 from the older laboratory of Pavlov dating from 1880.

Institute of Physiology, (Lina S. Stern); founded in 1929.

Moscow Botanical Gardens, (Tsitsin).

Laboratory of Physiological Chemistry, (V. O. Larnas); founded in 1943.

Laboratory of Helminthology, (Skryabin); reorganized in 1944.

Laboratory of Physiology of Speeches at Leningrad, (S. M. Dobrugauv); founded in 1938.

Laboratory of Hybrid Segregation at Leningrad, (Tsitsin); founded in 1944.

Laboratory of Evolutionary Micro-organisms, (Gamaleyah); founded in 1940.

Laboratory of Photosynthesis, (Richter); founded in 1930.

Laboratory of Capillary Microscopy at Leningrad, (Perfilev); founded in 1941.

Biological Station at Sevastopol, (Bodiansky); founded in 1871.

Piological Station at Murmansk, (Zernov); founded in 1938.

Biological Station at Borok, (named after Morozov); founded in 1939.

Commission on Parasitological Problems, (Sukhachev); founded in 1943.

Commission on the History of Biological Sciences; founded in 1944.

Commission on Filterable Viruses, (Gamaleyah); founded in 1940.

Commission on Physiological Optics; (Orbelli); founded in 1943.

U. S. S. R. Society of Physiologists, Biochemists and Phermacologists, (President: L. A. Orbelli); founded in 1916, reorganized in 1939.

U. S. S. R. Society of Helminthologists, (President: Skriabin); founded in 1922; reorganized in 1941.

The Entomological Society, (President: Pavlovsky); founded in 1860.

Soviet Russia has made great progress in biological sciences including plant genetics, agronomy, animal breeding, etc. The above imposing list of institutes under this Division is a pointer to the thoroughness with which research in biological sciences is now organized in U. S. S. R. The investigations of Trofim Lysenko in the vernalization of seeds, of Mitchurin, Derzharin, Tsitsin and others in plant hybridization, of Ivanov in livestock breeding, are well-known even outside Russia. As a result of these researches, excellent varieties of spring and perennial wheat are being grown in many parts of Russia, new sugar beet districts have been developed on the Kuban, the Saratov region and in the Altai territory, and Egyptian cotton is being raised in Azerbaidjan (Caucasus), and Turkmenia (Central Asia).

Facilities for the study of biological and botanical sciences under the Academy were greatly increased after 1929, when the main Botanical Gardens in Leningrad, formerly under the People's Commissariat of Agriculture of the R.S.F.S.R. (Russian Socialist Federated Soviet Republics), were transferred to the U. S. S. R. Academy of Sciences. These gardens were founded in 1714 by Peter I. The Academy had the Botanical Museum which was merged with the newly transferred Botanical Gardens.

From these two institutions has emerged the famous Botanical Institute of the Academy, which, in 1930, was renamed the Komarov Botanical Institute in honour of Vladimir Komarov, President of the Academy. The Institute's herbarium contained about 5 million specimens in 1943. The library of the Institute, containing more than 135,000 volumes which include the most important literature on the subject of botany since the 15th century, is one of the best libraries in the world.

Facilities for research are also available in the biological departments attached to the universities and the research establishments under the People's Commissariats. Another feature of biological researches is the organization of seats of research activities, both in theoretical and applied biology, in important cities of the U. S. S. R., such as in Tomsk, Kazan, Alma-Ata, Odessa, Sevastopol, Michurinask, etc., by individual leaders in the field of biology, most of whom happen to be pupils or followers of I. P. Pavlov, A. A. Ukhtomsky and others. Work in these city establishments, as in the universities and the Commissariats, forms part of the general programme for research in biological sciences, determined by the supreme scientific body, the U. S. S. R. Academy of Sciences.

Technical Sciences

The *Division of Technical Sciences* (Secretary: Bardin) includes:

The Krzizianovsky Institute of Energetics, (Krzizianovsky); founded in 1930.

Institute of Combustible Materials, (Nametkin); founded in 1934.

Institute of Metallurgy, (Bardin); founded in 1938.

Institute of Mine Engineering, (Skochinsky); founded in 1938 from the Committee stage in 1935.

Institute of Machine Science, (Chudakov); founded in 1938 from Committee stage in 1936.

Institute of Mechanics, (Galerkin); founded in 1938.

Institute of Automatics and Telemechanics, (Kovalenkov); reorganized in 1930.

Section on Scientific Elaboration of Problems of Transports, (Obrazshov); organized in 1938.

Section on Scientific Elaboration of Problems of Water Supply, (Sarbarensky); organized in 1930.

Section on Scientific Elaboration of Problems of Electrical Communications, (Vvedensky); reorganized in 1930.

Section on Scientific Elaboration of Problems of Electro-thermics, (Nikitin); organized in 1941.

Committee of Technical Terminology; founded in 1933.

Committee on History of Technology; reorganized in 1944.

The Technical Institutes and Commissions under the U.S.S.R. Academy of Sciences concentrate, as a rule, on the study of general and long-rage problems. From the nature of institutes given above, it would appear that these organize research work on a definite group of problems. The Academy has highly developed the Commission method of dealing with research problems so far as technical sciences are concerned. The Commissions are usually made up of representatives from universities, institutes and organizations concerned and are responsible for planning and co-ordination of research work. The various institutes and Commissions are financed by the State budget.

Research Institutes under People's Commissars

Besides the institutes and Commissions under the Academy, research work is carried out by the institutes under the People's Commissariats of Industry,* by the universities and colleges, and by the laboratories of the various industrial enterprises. The institutes under the People's Commissariats of Industries are financed partly by the State budget and partly by the various enterprises which submit research problems for solution on the basis of mutual contracts. This reminds us of the research establishments created under the Department of Scientific and Industrial Research in England, with which these have some resemblance. Each industrial commissariat maintains its own research institutes. Although these institutes are generally interested in problems concerning technical and applied branches of sciences, the study of general and theoretical problems forms a considerable part of their research programme.

History and Philosophy, Economics and Law, and Literature and Philology

We shall make only a passing reference to these three Divisions, as these are not 'immediately' connected with the progress of science. The mention of the institutes under these Divisions may be of some interest.

The *Division of History and Philosophy* includes the following research institutions:

- The Institute of History.
- The N. Y. Marr Institute of the History of Material Culture.
- The Institute of Ethnography.
- The Institute of Philosophy.
- The Museum of the History of Religion.
- The Archives of the Academy of Sciences of the U.S.S.R.
- The Commission on the History of the Academy of Sciences of the U.S.S.R.
- The Commission on the History of Technical and Natural Sciences.

The *Division of Economics and Law* includes the following research institutions:

- The Institute of World Economy and World Politics.
- The Institute of Economics.
- The Law Institute.

The *Division of Literature and Philology* includes the following research institutions:

- The Maxim Gorky Institute of World Literature.
- The Institute of Literature.
- The N. Y. Marr Institute of Philology and Logic.
- The Institute of the Languages and Literature of the Peoples of the U.S.S.R.
- The Oriental Institute.

Structure, Administration, Functions and Financial Aspects of the Institutes

After a brief resume of the scientific institutes under the various Divisions of the Academy of Sciences, we now propose to discuss the structure, administration, functions, and financial aspect, or in other words, the organizational side of the institutes.

Structure and Administration: The Präsidium of the U.S.S.R. Academy of Sciences, resembling the Council of scientific organizations in England, U. S. A., or elsewhere, is the supreme executive body from which authority emanates. The Prasidium determines the policy and function of the institute, sanctions the plan of work proposed by the institutes and approves of the budget estimate.

Each institute is headed by a Director responsible to the Präsidium and enjoying complete administrative and economic independence and the rights of one-man management. He has to organize all the work of the institute and exercise operative control over its activities so as to ensure proper fulfilment of tasks assigned to the institute.

The Director is assisted in his work by what is called the 'Academic Council', which is an advisory body working under the Director. The Academic Council is composed of members and corresponding members of the Academy, and of outstanding specialists in the corresponding fields of science and engineering. The Director is *ex-officio* the Chairman of the Council and suggests the names of members to serve the Council, to be approved of by the Präsidium.

The Academic Council is a very important feature of the organization of an institute. All matters concerning research, such as the trends of the institute's scientific activities, the problem of the co-ordination of research work, development of research in allied fields, publication of scientific papers, etc., are discussed by the Council. It can also appoint temporary commissions, whenever necessary, to work on problems in some special field.

Each institute has its laboratories, sections and well-equipped library, staffed by members and corres-

* For a detailed account of the institutes under the People's Commissariats of Industry, see the article on 'Organization of Science in the Soviet Union' by S. N. Sen in Science and Culture, Vol IX, No. 1.

ponding members of the Academy and by skilled specialists of the branches of knowledge concerned.

Functions of the Institutes.—The object of the institutes, as defined in the Statute and already mentioned, is the promotion of science and technology in all their ramifications in such a way as best serves the economic and cultural interests of a classless society. This social and national responsibility makes the question of planning and integration of scientific research extremely important in Russia. Thus, besides conducting research on the most urgent problems of science and engineering, culture and the national economy, the Academy institutes have to integrate the research work and secure a planned development of sciences in the U.S.S.R. The planning of research is a distinctive feature of those institutes.

Not less important is the training of scientific cadres at these institutes which had, according to an estimate of January 1, 1945, 1,200 post-graduate students. The institutes of the Academy's branches had more than 300 students. These institutes provide post-graduate training to the selected few from higher schools and colleges, aspiring after master's or doctor's degrees. Only the gifted graduates are trained to qualify for research degrees and are given the privilege of studying and learning at the highest research institutes of the Union.

Finance.—In U. S. S. R., the State is the owner and organizer of all enterprises, scientific or otherwise, and has, therefore, to provide funds for all activities. This simplifies the question as to the sources of fund, which is always a vexed problem in the capitalist countries thriving on private enterprise. Under finance, it is only important to note the ways in which funds are made available from the Government Treasury for the conduct of research and other activities of the Academy institutes. The following three ways may be mentioned:

(*a*) State budget allotments in accordance with the plan of work confirmed by the Präsidium of the Academy of Sciences.

(*b*) State budget allotments over and above the budget estimates, given to the institute by the Präsidium of the Academy, for the execution of special tasks and assignments.

(*c*) Funds obtained with the permission of the Präsidium of the Academy by contract with other institutions for the fulfilment of research work and for preparing exhaustive scientific works for press.

Science in Russia is a vital force today. It has determined her progress in peace and her victory in war. We conclude our discussion with an excerpt from a speech delivered by Stalin at a reception in the Kremlin to the higher educational workers on May 17, 1938. He proposed a toast

"To the progress of science, of that science which does not fence itself off from the people and does not hold aloof from them, but which is prepared to serve the people and to transmit to them all the benefits of science, and which does not serve the people under compulsion, but voluntarily and willingly.

"To the progress of science, of that science which will not permit its old and recognized leaders smugly to invest themselves in the robe of high priests and monopolists of science; which understands the meaning, significance and omnipotence of an alliance between the old scientists and the young scientists; which voluntarily and willingly throws open every door of science to the young forces of our country, and affords them the opportunity of scaling the peaks of science, and which recognizes that the future belongs to the young scientists.

"To the progress of science, of that science whose devotees, while understanding the power and significance of the established scientific traditions and ably utilizing them in the interests of science, are nevertheless not willing to be slaves of these traditions; the science which has the courage and determination to smash the old traditions, standards and views when they become antiquated and begin to act as a fetter on progress, and which is able to create new traditions, new standards and new views."

SCIENCE IN AUSTRALIA

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

AUSTRALIA'S premier Scientific Organization is the Commonwealth Council for Scientific and Industrial Research.

It largely combines the functions of certain sections of the Bureau of Agriculture and the National Standards Bureau in the United States, and the Department of Industrial Research and the Agricultural Ministry Research Council's work in Britain.

Although the Council was not formed until 1926, its origin really dates back to World War I.

In the early stages of that war, it was clear that Germany, because of her extensive chemical industry, was in a peculiarly advantageous position in making arms. In fact, the whole world was dependent on German dyes—and dye factories can be changed almost overnight to munitions factories.

To rectify the position, Britain set up a dye industry and a Department of Scientific and Industrial Research. At that time Dominion Prime Ministers were in Britain, and it was suggested that they should set up research organizations in their own countries.

So in 1916, the then Australian Prime Minister, William Morris Hughes (who, now 81 years of age, is still a member of the Commonwealth Parliament) established the Advisory Council of Science and Industry. Later the name of this body was changed to the Institute of Science and Industry.

In 1926, the set-up was re-organized and the present Council for Scientific and Industrial Research created.

The powers and functions of the Council were defined by the Science and Industry Act, 1926. They include the initiation and carrying out of research for primary and secondary industry, the training of research workers, the making of research grants, and the setting up of a bureau for collecting and disseminating scientific and technical information. But human health problems do not come within the Council's purview; they are the concern of the Commonwealth Health Department.

The need for the organization and equipment of research on a national scale has developed and increased largely through improved transport methods. Conditions today are forcing efficiency on primary and secondary industries alike. And efficiency can only be achieved by using scientific knowledge to perfect production methods, and scientific investigation to clear up the various problems arising in industry.

The comprehensive nature of the Council's activities has necessitated a widespread and adaptable organization. Undesirable centralization has been avoided by establishing State Committees, each of which consists of a chairman selected by the Commonwealth Government, three members nominated by the State Government from the staff of its scientific departments, and three scientists, at least two of them members of the local university staff. In addition, the chairman and six members appointed under this plan have the right to nominate three members associated with industry. Additional members may be co-opted from time to time because of their specialized knowledge.

These committees in the six Australian States advise the Council on general matters, and also on particular questions of investigation and research.

The full Council is made up of 20 members who come from all States of the Commonwealth. There are three members nominated by the Commonwealth Government and the chairmen of the six State Committees, and other members co-opted because of their specialized knowledge.

Commonwealth Government appointees are Sir George Julius Kt., D.Sc., B.E., who is chairman of the Council; Sir David Rivett, K.C.M.G., M.A., D.Sc., F.R.S., who is deputy chairman and chief executive officer; and Professor Arnold Edwin Victor Richardson, who is Director of the Waite Agricultural Research Institute in Adelaide and the Council's deputy chief executive officer. The Council's headquarters are in Melbourne, and its meetings are usually held there.

C. S. I. R. officers include specialists in almost every branch of pure and applied science. Most are permanent members of the scientific staff, but some are appointed for specific short-term investigations. Some of the Council's research workers are housed in its own laboratories, others work side by side with State Government officers, either in departmental laboratories or in the field. Some work in universities carrying out research under the general supervision of members of the university staff, and a few are stationed overseas.

Co-operation with State and Commonwealth Departments, and with universities, has been an outstanding feature of the Council's operations. The consequent team work has been extremely valuable in a country like Australia, with its many problems and comparative paucity of trained research workers.

In its early years, the Council concentrated on the primary industry field. It was beyond the capacity of any individual man on the land to study thoroughly animal diseases, plant diseases, soil and water difficulties, nor could he finance adequate research. The various State Departments of Agriculture welcomed this line of research into far-reaching national problems as distinct from problems affecting more restricted localities.

So the Council's first move was to set up Divisions of Plant Industry, of Economic Entomology, of Animal Health, of Soils, and of Food Preservation and Transport, with smaller sections to look into problems of citriculture and viticulture under irrigation conditions.

The Plant Industry Division has its headquarters in Canberra, alongside the main laboratory of the Economic Entomology Division.

The main work it undertakes concerns plant breeding, plant diseases, horticulture, tobacco, weeds, plant production and pasture problems. Special attention is given to pasture investigation as grass is the most important crop grown in Australia. Just now there is an urgent need for the development of a pastoral mixture that will stand up to tropical conditions, and enable northern areas to be settled far more intensively.

Earlier divisional officers gained world fame by evolving a simple, practical and effective way of raising healthy tobacco seedling free from blue mould.

Although the Division has more than a hundred acres of land close to its main laboratory for field experiments, its officers carry out special investigations all over Australia. Some are permanently located in Tasmania working on fruit storage troubles, and others in Queensland working on plant introduction and agrostological problems.

This Division operates in a field in which much experimental work has been done, and is being done, by State Departments of Agriculture. Therefore, generally the division concerns itself with problems affecting more than one State.

Economic Entomology Division

The Economic Entomology Division also has its laboratories at Black Mountain in Canberra. It is mainly concerned with the control of insect pests. Particular attention has been given to the sheep blowfly, which used to cost the Australian sheep farmer anything up to Rupees four crores a year. Other pests investigated include the cattle tick, the buffalo grub, the red mite, the lucern flea, and thrip.

The most spectacular work done by the division is the control of noxious weeds by insects. Already much success has been achieved in controlling lantana and St. John's wort (despite the difficulty that Australian ants have a special liking for the insect, which is disastrous to St. John's wort if allowed to work unchecked).

The Council's entomologists played a big part earlier in helping to wipe out prickly pear in northern N.S.W. and Queensland, thus peacefully regaining for Australia about 60,000,000 acres of land.

The story, in brief, is that the prickly pear is not a nuisance in the countries in which it originated. Apparently it is kept in check there by some insect which was not introduced into Australia with the plant. With nothing to keep it in check, prickly pear spread swiftly in Queensland and N.S.W. A search was made in other countries for an insect that would keep the pear down.

Ultimately, one such insect—cactoblastis cactorum—was found. This particular insect is surprisingly easy to handle and control. Firstly, the moth lays its eggs on top of one another to resemble a cactus spine. So, in one snip, about 200 eggs can be collected. (At one time these eggs spines were collected literally by the four-gallon tin).

Secondly, the caterpillar bores into the soft fleshy pads and eats the pear away while safely protected from birds and its other natural enemies. Thirdly, the insect will not live on any plant other than prickly pear, and is thus harmless to crops.

Division of Animal Health and Nutrition

The Division of Animal Health and Nutrition is one of the least centralized sections. Its headquarters are in Melbourne, but its veterinarians and bacteriologists also work at stations in northern Queensland, Sydney, Adelaide and Perth.

Their work is vital to Australia for anything which adversely affects the continent's great pastoral industry and strikes at the roots of the country's wealth and prosperity.

Main problems the division has investigated are, or have been, pleuro-pneumonia in cattle, tick fever, mastitis and peg leg in dairy cattle, sheep blowfly, worms and other parasites, enter-toxaemia, Denmark disease, botulism in sheep, flurosis, fertility, Zebu, hybridization, toxaemic jaundice and foot-rot.

One of the divisions's most successful investigations was that into black disease in sheep (infectious necrotic hepatitis) which formerly caused pastoralists losses up to Rupees one crore a year.

This disease was first referred to as "braxy-like" disease because of its resemblance to the braxy of European countries. The disease is fatal, and the affected animals die so quickly that it is rare to be

able to pick them out before death. Usually the pastoralist finds fresh carcasses each day while the rest of the flock is in good condition.

However, investigations show that the disease is due to a bacillus which is stimulated into growth and invasions by the lesions caused by young flukes entering into the liver tissues. Researchists prepared a vaccine capable of protecting animals against the infecting organism. The use of this vaccine together with methods of eradicating liver fluke, has kept the disease well under control.

The division's work with pleuro-pneumonia in cattle has also received world-wide recognition, for it has been as important from the purely scientific viewpoint as it has been successful from the practical.

In the first place the exact nature of the casual organism, long thought to be one of the so-called filterable viruses, has been cleared up. A technique for culturing it in vitro has been evolved, using what is known as the V.S.O.S. broth (which is a peptic digest of ox liver and muscle, enriched by the addition of ox serum, and sterilized). From the pure cultures of the organism a vaccine has been developed which confers a high degree of immunity on the beast inoculated with it.

Division of Soils

The Division of Soils has its headquarters at the Waite Agricultural Research Institute of the Adelaide University. Its main task is to examine, and classify soils to obtain a fundamental knowledge on which the best methods for using those soils can be based.

The work takes up a lot of time, so attention in the early years was naturally focussed on the high-priced soils of the irrigation districts, which are centres of intensive production today.

One of the biggest jobs has been the surveying of the irrigation settlements along the River Murray. In the course of this work, a survey was made of the bed of Lake Albert at the mouth of the river. This was done from motor launch through several feet of water. Special apparatus, now in use throughout the world, had to be made for the job. The object was to find out whether the soil of the lake bed was suitable for dry farming or irrigation farming.

The survey showed that about half the area of the lake, comprising a shallow layer of clay over sand or rock, would probably be of little value in an irrigation project or for dry farming. Even the more promising deep clay soils, constituting as they would the lower parts of the dry area, might be expected to develop salt troubles. Therefore the reclamation scheme was dropped.

Division of Biochemistry and General Nutrition

The Division of Biochemistry and General Nutrition is another laboratory with headquarters in Adelaide. It specializes largely in sheep problems. Experimental animals maintained in the laboratory "zoo" are fed measured amounts of different fodders, and the passage of this food through the animals is watched carefully by examining their breath and their excreta. Through this work the precise food needs of sheep, particularly under drought conditions, have been determined.

This division has established the importance of very small amounts of metal such as copper and cobalt to sheep. For many years, sheep kept on apparently good soils over several thousand miles of land in the south of the continent, particularly in Western Australia, did not flourish and their wool was poor. Through investigations their condition was put down to the absence of cobalt and copper. Top dressing of the pastures with a few pounds of salts of copper and cobalt to the acre, or, alternatively the giving of licks containing these materials, has led to a remarkable improvement in the animals in these areas and often trebled the value of that land.

Division of Food Preservation and Transport

The Division of Food Preservation and Transport which has its main laboratory in Sydney is another of the major primary industry divisions of the C. S. I. R.

Australia is a long way from the main food importing countries of the world, and is itself a land of great distances. So the handling and transport of perishable products is a vital national problem.

The division's main lines of work concern cold storage, dehydration and canning of meat, fruit and vegetables.

Before the war, the Division showed the way to the development of an export trade in chilled beef to the United Kingdom—a trade which had not previously existed because of the lack of technical knowledge of how to keep the beef satisfactorily in a chilled condition for the long period involved.

Since the war, the division has helped Australia to meet her obligations to the Allied fighting forces in the Pacific and Allied civilians abroad by investigating and improving dehydration, canning and similar methods of food preservation, and also in ensuring that it is adequately packed to stand up to transport through steamy jungles and long sea voyages.

Forests Products Division

The Forests Products Division has carried on the work on the many native timbers begun by the Advisory Council of Science and Industry.

Its main achievement has been the production of paper from the short-fibred Australian eucalypt timbers. Paper experts, accustomed to the long fibred Northern Hemisphere timbers, said the Australian timbers were unsuitable for making paper. But the Australian research workers would not accept this opinion. And now, largely through their determination, there are three big and important paper industries all using Australian timbers.

They are the wrapping paper factory at Maryvale (Victoria); the newsprint mills near Hobart, Tasmania, and the works at Burnie in Tasmania, producing fine-printings.

In recent years the Division has set up sections dealing with the strength of timbers and their seasoning, preservation, chemistry and their identification.

Fisheries Division

The Fisheries Division has its headquarters at Cronulla, about 20 miles south of Sydney. The division's main laboratory there looks into the fish food content of Australian waters and their ocean currents, the classification of Australian fish, and their smoking and preservation. A trawler is used to investigate fish occurrences and ways of catching the surface swimming (pelagic) varieties.

The division has given a great deal of attention to "spotting" fish from airplanes. This method of directing fishermen to the best grounds may be used extensively after the war.

National Standards Laboratory

These primary divisions were running smoothly when the Council decided to turn its attention to the manufacturing side in 1936-37. Recommendations that an Australian national standards laboratory, an aircraft and engine testing research laboratory, and a research service for secondary industry in such fields as metallurgy, chemistry, physics and engineering should be set up within the structure of the C.S.I.R., were accepted by the Government of the day.

It is fortunate for Australia that this was done two years before the war, because these sections have proved invaluable to Australia's great war production effort.

The National Standards Laboratory in Sydney is the Australian counterpart of the National Physics Laboratory in England, and the Bureau of Standards in U. S. A. It is concerned with the precise measurement of length, mass, volume, time, temperature, humidity, density, and electric current.

The laboratory has three main sections dealing with meteorology, physics and electro-technology.

The meteorology section studies the production and calibration of gauges and other measuring instruments for making precision machinery and munitions. The physics section deals with problems of heat, light, sound and X-rays, while the electro-technology section deals with a wide variety of electrical and radio matters other than those carried out by the Radio Research Board.

Radio Research Board

This Radio Research Board, which was set up in 1927, has made rather fundamental studies of the ionosphere or upper regions of the atmosphere, the effect of variations of conditions in these regions, and the reflection of radio waves.

Some of the results obtained from the board's investigations have now been put to practical use, particularly in the armed services' signalling and radar activities. Details of this work cannot be given now for security reasons.

Aeronautics Division

The Aeronautics Division has extensive experimental facilities at its main laboratory in Melbourne. The work of the laboratory is divided into four sections, dealing with aerodynamics, structures and materials, engines and fuels and instruments. It has two wind testing tunnels—the smaller one a high speed tunnel in which air can be circulated at a speed equal to 750 miles an hour.

Industrial Chemistry Division

The Industrial Chemistry Division, also headquartered in Melbourne, has played a big part in the development of Australian manufacturing industry, and is destined to play an even greater part after the war. The aims of the division are to promote greater technical efficiency, to help in the setting up of new industries, to encourage the use of Australian raw materials, to seek substitutes for imported materials, and to find uses for by-products.

The Division has a Minerals Section, which investigates such problems as the production of potash, chromium compounds, graphite, and lithium and veryllium compounds. Another section deals with cement problems, another with biochemical

matters particularly fellmongering. The organic section studies resins, essential oils, alkaloids and tannins from Australian shrubs and trees, and syntheses of new organic compounds for use as insecticides and fungicides, and for the floatation of minerals.

The Lubricants and Bearings Section, housed in the laboratories on the Chemistry School at the Melbourne University, is independent of any division. It studies friction and wear on metals, and applications of the results of some of its investigations have proved extremely valuable to munition factories in Australia and abroad.

The C.S.I.R. is also interested in many other investigations in such fields as ore-dressing, mineragraphy and mathematical statistics.

In the past five years the Council has concentrated primarily on many and varied war effort problems. But when the war against Japan is finished the Council's trained staff of 2,000 and its great resources will be available for tackling post-war reconstruction problems.

A PLEA FOR AN ALL BENGAL ELECTRICAL GRID

V. L. N. ROW

Introduction

ELECTRICAL energy has of late become one of the fundamental necessaries of life and is no longer a monopolized legacy of the rich. It is a great pity that the development of electric power has so far been quite meagre, as has been repeatedly referred to in the columns of SCIENCE AND CULTURE. The sponsors of the Bombay Plan have emphasized its importance by saying that not even half a million out of the country's total estimated potential resources of more than 27 million kilowatts has been developed. Among the various provinces of India again, Bengal represents the saddest and most disappointing picture in the matter of electrical development. Most other provinces have initiated hydro-electric and thermal projects and can claim to have made some progress though small. The backwardness of Bengal may be attributed in the last analysis to the lack of a well laid out plan which she is now so urgently in need of.

Since planning for post-war development has been actively taken up both by the Central and Provincial Governments and as electricity forms a Provincial subject, it is high time that the Government should immediately form a technical board and draft out a regular grid scheme as soon as possible, and devise ways and means to translate the scheme into operation as soon as the hostilities cease. It, however, remains to be seen how far the newly formed Central Electricity Board will be useful in this direction.

While planning for Bengal, one must remember that problems of the power development of this province are different in more respects than one from those experienced in other provinces and should accordingly receive different treatment. In the present article, an attempt will be made to indicate how the introduction of an electrical grid system operating throughout the province is calculated to solve the power problem of Bengal.

Economics of Electrical Industry

Unlike many other useful commodities of life electricity cannot be stocked or made elsewhere and dumped here. Besides, unlike any other complicated machines or intricate alloys and steels, the quality of electricity, whether generated in Sheffield or Muzaffarpur, is just the same, and the rich and the poor, the capitalist and socialist, the learned and the labourer all use the same quality of electricity for whatever purpose they may require it. These two factors influence to a large extent the economic background of the production and distribution of electrical energy.

Further, electricity becomes cheaper when it is produced on a large scale. But, unlike any other industry where the ratio of the value of gross annual output to the cost of the unit of production is of the order of 100 per cent, the electrical industry has a very low ratio which is about 15 to 25 per cent. Since adequate returns on the capital investment are not assured in this industry, private enterprise has been limited except where long term monopolistic licenses are issued to safeguard competition and meagre annual return in the intial stages. Who should, therefore, be the correct agency is still a much debated problem.

Apart from the development of large-scale industries in a few scattered cities and towns, a well laid-out electrical distribution system in Bengal, when properly worked out, will doubtless bring about the much needed industrialization of the moffusil and rural areas and will further greatly contribute to the development of agriculture by providing cheap electricity. This diversion of industries into the interior of Bengal is the most necessary and desirable drive. It will effect a uniform distribution of employment throughout the province and will thus control the large influx of moffusil population into the metro-

polis, leading to the scarcity of housing accommodation, sanitary and other difficulties characteristic of a city.

This important problem of decentralization of industries in the moffusil districts throughout the country instead of crowding the cities and depleting the villages has curiously enough escaped the notice of the Bombay Planners.

The Present Position

At present there are roughly about 50 electric licenses in this province, out of which about 14 are held by the Calcutta Electric Supply Corporation itself. All these are company managed except the one at Darjeeling which is a municipal undertaking. For large-scale and quick development a large hydro-electric or thermal grid scheme is essential. Though the largest group of hydro-electric and steam power stations in India are owned by private enterprises like the Tata Hydro-Electric and Calcutta Electric Supply and Tramways Co. Ltd., most others like the Mundy and Malakand schemes in the north west or the Ganges Valley Hydro-Electric in the north and the Sivasamudram, Pykara and Mettur Power Schemes in the south would not have come into existence except for Government activity. Interconnection of power stations and large scale-generation have always been found to be best done by an independent Government constituted body.

At present, some 44 towns, including Calcutta and suburbs, are enjoying the privilege of electric supply, of which the list is given in table I, column 1. The approximate loads of the towns are also indicated in column 2.

Future Possibilities

It is a very regrettable fact that the Government have not rendered any financial help whatsoever to any business undertaking except to the municipal undertaking of electric supply at Darjeeling. The apathy of the Government, the present discriminating licensing system for which the Government are again responsible, and the failure to command adequate finance not forthcoming have largely arrested electrical development in Bengal.

There are many towns with a population of over 5000 which can be electrified straightway. The columns 3 and 4 of Table I, giving the list of such towns and their estimated loads will be of great assistance to investing public or companies who are desirous of extending their activities.

A Suggested Grid Scheme

Mr Redelift, Electrical Adviser to the Government of Bengal, has suggested the following scheme

TABLE I

Present Position		Possibilities of Extension	
Towns	Load (in kilo-watts)	Towns	Load (in kilo-watts)
Calcutta and Suburbs— (Bally-Uttarpara Dum Dum Howrah Serampore Lillooah Rishra, Konnagar Kamarhatty, Belgharia, Agarpara Budge Budge & Bauria Baidyabati, Champdany & Bhadreswar Panihati, Khardiah, Titagarh)	1·57, 640	Kalna ..	87
		Katwa ..	84
		Kulti ..	44
		Suri ..	114
		Rampurhat ..	88
		Bishnupur ..	145
		Sonamukhi ..	89
		Kharagpur ..	221
		Tamluk ..	91
		Ghatal ..	69
		Chandrakona ..	53
		Ramjibonpur ..	47
		Kharar ..	39
		Arambagh ..	57
		Kancharapara ..	53
		Halishahar ..	39
		Rajpur ..	102
		Baruipur ..	55
		Jaynagar-Majilpur	26
Barrackpore ..	196	Barasat ..	159
Bhatpara Riverside ..	319	Baduria ..	71
		Basirhat ..	186
Bhatpara, Noapara, Gurulia		Taki ..	86
		Santipur ..	269
Naihati ..	42	Ranaghat ..	95
Gauripore ..	16, 300	Meherpur ..	59
Hooghly-Chinsurah ..	156	Murshidabad ..	115
		Beldanga ..	33
Bansberia ..	3	Jiaganj-Azimganj	89
Barisal ..	114	Kandi ..	69
Burdwan ..	255	Jangipur ..	91
Bankura .	27	Dhulian ..	92
Krishnagar ..	62	Kotchandpur ..	52
Khulna ..	101	Satkhira ..	82
Chittagong ..	358	Debhatta ..	32
Comilla ..	96	Muktagacha ..	35
Chandpur ..	80	Gouripore ..	33
Faridpur ..	67	Jamalpore ..	101
Narayanganj ..	178	Sherpur .	101
Munshiganj ..	22	Kishorganj ..	110
Dacca ..	923	Bajitpur ..	80
Bhairab Bazar .	18	Netrokona ..	70
Tangail	5	Madanpur ..	104
Serajganj .	89	Rajbari ..	59
Mymensingh ..	199	Pirojpur ..	71
Pabna ..	83	Bhola ..	59
Kustia ..	13	Cox's Bazar ..	35
Berhampur ..	85	Brahmanbaria ..	176
Rajshahi ..	108	Noakhali ..	28
Malda ..	54	Feni ..	61
Rangpur ..	85	Dinajpur ..	140
Jalpaiguri ..	94	Siliguri ..	22
Kurseong ..	120	Saidpur .	63
Kalimpong ..	51	Kurigram ..	4
Darjeeling ..	640	Gaibandha ..	45
Raneegunj ..	125	Bogra ..	195
Asansol ..	116	Nawabganj ..	109
	associated power	Contai ..	38
Coalfield area ..	3,000		
Dishergarh .	5,600		
Barakar ..	20		
Midnapore ..	114		
Patuakhali ..	17 works only		
Nabadwip ..	42		
Natore ..	50		
Jessore ..	80		
Jhalakati ..	20		

of five generating areas which are to be interlinked in his "Preliminary Report on the position of Electrification of Bengal" issued in 1930. The position of course has got to be reviewed and recast, and with slight modifications a similar plan could be formulated and operated even now.

He divided Bengal into 5 separate generation areas as follows:

(1) A hydro-electric power station to be erected utilizing the waters of the river Teesta or Jaldhaka. This would supply electricity for the whole of North Bengal as far south as the river Ganges and as far east as the river Prahmaputra. This power station could also supply the whole of the Dooars and possibly Cooch Behar and any load in the neighbouring regions of North Assam.

(2) The second area could be conveniently supplied from steam driven power stations in the coal fields and from Calcutta.

(3) The district of Bankura and a portion of Midnapore could be supplied from the proposed large Behar Government thermal station.

(4) The district of Mymensingh and Dacca could be supplied from a thermal power station at Cherrapunji where a hydro-electric power station is not advisable on account of the risk of earthquake tremors.

(5) A hydro-electric project utilizing the waters of the river Karnafuli could supply the Tippera, Noakhali and Chittagong areas.

Financing of the Scheme

As regards finance for the scheme Bengal derives about Rs. 20 lakhs annually from the present electricity tax and this could solely be utilized for this purpose. Further, the Government should raise funds as public subscriptions and loans as envisaged in the Bombay Plan and should encourage private enterprise with certain safeguards and privileges. The present method of taxing the poor domestic consumer much more than the industrialist to whom goes the greater share of benefits from cheap power should also be radically changed.

Mr Redclift is of opinion that the completion of this scheme which would ensure the supply of electricity within 5 miles of the remotest village would involve an expenditure of about Rs. 6 crores. If this money be readily forthcoming, the execution of the scheme, he believes, would not require more than a decade.

DISEASES OF RICE AND METHODS FOR THEIR CONTROL

J. C. SAHA,
BOTANY DEPARTMENT, PRESIDENCY COLLEGE, CALCUTTA

(Continued from the last issue)

Downy Mildew

Cause: *Sclerospora macrospora* Sacc.

This disease is not commonly met with. It is characterised by the production of excessive tillerings, hypertrophy and considerable twisting of the foliage, the latter being covered with white downy growth. The inflorescence of such diseased plants are greatly distorted.

Occurrence.—The disease has been reported from Italy and the United States.

Blast Disease*

Cause: *Piricularia oryzae* Bri. et. Cav.

This is a very destructive disease of rice attacking different parts of the plant. On one or both the surfaces of the leaves or sheaths reddish or brownish spots are formed. The centre of these soon becomes ashy-grey ultimately turning smoky and soiled in colour due to the appearance of spores and sporophores at that region. These minute brownish spots



Fig. 3. Blast Disease.

gradually develop into elongated or oval brown areas, ½ inch by ¼ inch. Sometimes the adjacent spots merge together and extend along nearly the whole length on one side of the midrib or they may extend across it and the leaf gradually withers and dries up. Infection sometimes occurs at the junction of the leaf blade and sheath ; the infected tissues in such cases loose their turgor and the blade falls over, and such infected regions appear very dark brown. If the infected region of the leaf sheath touches the stem inside, the stem may get diseased at that region from where it spreads upward or downward turning the infected tissues almost black. In severe cases the stem collapses and bends over at this place. When the flag leaf enclosing the ear is attacked, the glumes that are in touch with the spots may also become spotted. The ear when appears normal, has in most cases the grains improperly filled or almost sterile ; the sterile heads remain standing erect. The greatest damage is caused when the nodes and the necks of the panicles are attacked.

Occurrence.—This disease has been noted in almost every rice growing country of the world and its effects are variously known in different places, namely, 'blast' in English, 'imochi' in Japan, 'falla' in Spain, 'brusone' in Italy, and 'spot disease' in Bulgaria.

Control Measures.—In Italy and United States the serious damage caused by this disease has been prevented by spraying the plants with Bordeaux mixture while it is in the seed bed. Beneficial results have also been obtained elsewhere by the application to the field of superphosphate with the addition of lime, calcium carbonate or gypsum to the manures. The application of heavy doses (60 lbs. per acre) of nitrogen (in the form of ammonium sulphate) makes the plant susceptible to blast while smaller doses are said to be beneficial. The effect of nitrogen can be counteracted to a good extent by the application of potash but not by phosphoric acid. Soaking of seeds in 2% solution of Kalimat B for 24 hours not only reduces greatly the incidence of the disease but is also said to have a beneficial effect towards increasing the yield (Tuteff, 1928).

Yellow Kernel Disease

Cause : *Protoascus colorans*

The fungus attacks only the grains after they are fully formed and no other part is susceptible to its infection. The pathogen starts its activity during the time of curing after harvest. The disease is characterised by the yellow discolouration of the kernel due to the production of yellowish brown pigments by the fungus which permeates through the whole of the grain.

The development of the disease is favoured by humid atmosphere and high temperature, and so when stacked or stored in moist, warm places or transported in warm, damp cars for considerable distance the damage becomes much more than when these conditions are avoided. Further, pigmentation fails to develop at all if the grains are killed soon after harvest.

The disease is known as 'stack-burn' in some countries.

Occurrence.—This disease is known to occur in Indo-China, Java, Louisiana.

Control Measures.—Nothing much is known on this aspect. Conditions that favour the development of the disease should be avoided.

"Myitpo" Disease

Cause : *Probably Biological*

A diseased condition of paddy known as "Myitpo" in Burmese occurs in some irrigated tracts of dry zone in Burma, *viz.*, Shwebo district. The disease appears in patches of 30 to 100 ft. or more in diameter, the plants over the region become stunted in growth sometime after transplantation, turn yellow with the ultimate withering and drying up of leaves.

The disease is "probably caused by a biological agent". Nothing more is known about the disease. Further researches need to be under-taken to determine the nature of the responsible biological agent, the extent of damage caused, etc.

Control Measures.—The disease does not appear in the same field every year. Early and fair distribution of rainfall tends to prevent the outbreak of the disease.

The application of soluble phosphatic manures effectively controls the disease.

Black Kernel Disease

Cause : *Carvlaria lunata*, and others to a small extent.

The disease affects the grains but does not become evident until after milling. The grain turns jet black throughout but does not loose its natural hardness. The fungus responsible for such discoloured grains is *Carvularia lunata*, which produces minute, dot-like fructifications over the surface of infected grains. A number of other fungi are associated with "black kernel" but the grains in such cases have a softer and chalky texture and therefore degenerate in milling processes ; so the finished products become free from such black grains. The fungi responsible for the latter condition are *Helminthosporium oryzae* and *Alternaria* spp. Another, *viz.*, *Trichoconis*

caudata produces small superficial spots on the surface of the grains but these are removed in milling. Other fungi found associated with black grains are: *Rhizopus spp.*, *Penicillium spp.* and *Fusarium spp.*

The ovary is susceptible to infection when the flowers are in blossom. The natural source of infection is rice straw stag where *C. lunata* finds a suitable medium for overwintering. The spores are dessiminated by high wind or blast during dry days at the time when the flowers are in blossom next season. Volunteer rice or weeds near about rice fields also serve as alternate hosts. The rice stink bug, *Solubea pagnav* Fab. sometimes helps in the entrance of the casual fungus or fungi through punctures made in feeding upon the developing grains.

It may be mentioned here that slightly infected kernels do not result in black grains unless the grains get heated in the stack.

Though the number of affected grains rarely exceeds more than 1 per cent in the finished product the market price is reduced much in proportion because buyers dislike the quality that contains such black ones. So, grains containing them have got to be deeply milled and this increases cost of milling.

Occurrence.—The disease is reported from Indo-China, Japan and U.S.A.

Control Measures.—The practice of the following measures effectively check the spread and further progress of the disease: (1) avoidance of dampness in storage, (2) eradication or burning of weeds and volunteer rice about the rice field, and (3) avoidance of making straw stags in rice growing localities where there had been an out-break of the disease that year.

Cercospora Leaf Spot Disease

Cause: *Cercospora oryzae* Miyake

Cercospora leaf spot, also known as "narrow brown leaf spot" in American countries, is characterised by the production of linear spots 3 to 8 mm. long and 1 to 1½ mm. broad at most, parallel to the long axis of the leaf blade. The disease can easily be distinguished from other leaf spot diseases because of the very linear nature of the spots. The centre of the spots (*i.e.* the median axis) to the extent of ¼ mm. broad is dark brown, the border fading out as the outer margin is approached. The centre does not appear breached as is common with other leaf spot diseases. The spots or lesions produced on sheath are like those on leaf, those on the peduncle are narrower while those on the glumes are much shorter and nearly oblong. The lessions on less susceptible varieties are uniformly dark brown and much narrower.

The injury consists in the loss of vigour of the plants due to the reduction in photosynthetic areas.

Occurrence.—The disease is reported from Burma, China, Japan, Dutch East Indies, Brazil, Argentina, Puerto Rico, and Dominican Republic. In the United States of America, Arkansas, Texas and Louisiana suffer much.

Control Measures.—The disease shows much differences in varietal susceptibilities. So, control measures should be sought in the direction of selection and use of resistant varieties.

White Tip Disease

Cause: *Physiological*

"White tip" appears in paddy during the middle or later part of the season; the tips of one or a few leaves being attacked first. In case of mild attack it is characterised by the appearance of white chlorotic areas ½ to 1 in. in length at the tips while in case of severe attack the whitening travels further down affecting half the length of the leaf. The area thus affected becomes papery in texture and the leaf tip to the extent of 1 in. dies and dries up. Besides these, when the flag leaf is attacked the sheath enclosing the ear becomes rolled up with the result that the ear cannot come out in the normal way and so has to force its way through the sides. Such ears become deformed and the grains aborted or sterile.

Occurrence.—The disease is known in some parts of U.S.A., *viz.*, Arkansas, Louisiana and Puetro Rico.

Control Measures.—The following measures have been recommended against this disease:

1. Acidification of alkaline soil with sulphur or sulphuric acid.
2. Application of 300 lbs. of magnesium sulphate or 500 lbs. of a high magnesium lime per acre.
3. The use of nitrogenous fertilizers favourable under Louisiana conditions.

General Control Practices

In the descriptive section attention has been directed to individual cases of control measures, some of which are beyond the practices that can possibly be taken to by the common cultivators of this country, where even at the present day the time-old methods are practised. Moreover, many of the direct treatments do not repay cost. But most of the maladies can however, be prevented or checked to a good extent if some precautions are observed, which may be enumerated as follows:—

(1) Field selection—select fields which are well cultivated and have proper drainage arrangement.

(2) Seed selection—first select seeds that are normal and free from any diseased spots or other abnormalities as seen by naked eyes ; then immerse the selected grains in a salt solution (as in Japan and Siam), in a sugar solution (as in Java) or in ordinary water. The more solid grains settle down while the lighter and defective grains remain floating. Reject the latter and propagate the former. Where hand selection is not possible where large quantity of seeds are required carefully winnow or float away the lighter grains.

(3) Propagation—of definitely more resistant varieties where known.

(4) Rotation of crop—as the effect of different diseases is cumulative especially in the case of those fungi that attack the under-ground parts or preserve their spores in the soil, rotation of crop is a most useful means of checking the renewed attack of such diseases.

(5) Raising of seeds—seed grains should not be raised at random. It is better that a certain area should be set apart for the purpose and greater attention should be paid for maintaining healthy conditions of the plants and their disease-freeness.

(6) Sterilization of seeds—grains that are meant for sowing should be sterilised to check the seed-borne diseases before sowing. Treatment with 2 per cent copper sulphate solution or '3 per cent solution of commercial formalin in water for 10 to 15 minutes has been found beneficial in some cases. In both the cases the seeds should be quickly dried after the treatment is over and sown as soon as possible since both of them cause germination injury on storage. In case of treatment with copper sulphate solution, it is recommended that the seed, after being dried of copper sulphate sol., should be immersed for 3 minutes in a '5 per cent solution of quicklime in water. This almost neutralizes the injurious action of the copper sulphate.

(7) Sanitation of the field—all stubbles, trash and other debris should not be allowed to accumulate near any cultivated field.

(8) Eradication of diseased plants—plants that are found to be attacked with any disease should at once be uprooted and burnt. In the case of severe attack, the plants in the immediate vicinity should also be removed and burnt.*

List of Fungi Reported Associated with Different Parts of Rice Plant or Grains more about which is not known

Alternaria sp.
Ascochyta oryzae Catt.
Cercospora oryzae Miyake.
Chaetophora glumarum Miyake.
,, *oryzae* Cav.
Cladosporium oryzae Miyake.
Coniothyrium anomale Miyake.
,, *brevesporium* Miyake.
,, *japonicum* Milake.
,, *oryzae* Cav.
Dactylaria grisea Shirai.
Dimemasporium oryzae Miyake.
Diplodella oryzae Miyake.
Diplodia oryzae Miyake.
Entyloma sp.
Epicoccum hyalopes Miyake.
,, *neglectum* Desm.
Epidochium oryzae Miyake.
Gibberella saubinetti (Mont) Sacc.
Gonium oryzae Miyake.
Helminthosporium Halodes.
Hendersonia oryzae Miyake.
Leptosphaeria culmifragh (Fr.) Cess & de Not.
Melanospora glumarum Miyake.
Melasphaeria albescens Thum.
Mycosphaerella (*Sphaerella*) *Hondai* Miyake.
,, *Shiraina* Miyake.
Napicladium sp.
Nectria bolbophylli Henn.
Nigrospora sphaerica (Sacc.) Mason.
Oospora oryzetorum Sacc.
Ophiobolus oryzae Miyake.
Penicillium sp.
Phacosphaeria cattanei V. Thum.
,, *oryzae* Miyake.
Phoma glumarum Ell. & Tracy.
,, *oryzae* CK. & Mass.
Phyllosticta glumarum Ell. et. Tracy.
,, *Japonicum* Miyake.
,, *miurai* Miyake.
Piricularia glumarum (Ell. & Tr.) Sacc
,, *grisea.*
,, *japonica* Miyake.
,, *miurai* Miyake.
Pleosphaerulina oryzae Miyake.
Protoascus colorans.
Puccinia oryzae.
Pyrenochaeta oryzae Shirai.
Rhizopus sp.
Sclerospora macrospora Sacc.
Sclerotium glumale Miyake.
,, *irregulare* Miyake.
Septoria curcula Miyake.
,, *longispora* Miyake.
Sphaeoseptoria oryzae Miyake.
Sphaerella (*Mycosphaerella*) *malinveriniana* Catt.
Sphaeronema oryzae Miyake.
Sphaeropsis japonicum Miyake.
,, *oryzae* Miyake.
Sporotrichum sp.
Trichonis candata.

Bibliography

Abe, T., Experimental studies on the fungus injurious to rice seedlings. *Plant Protection, 14,* No. 10, 1927 (Japanese). (Abs. in *Japan. Journ. Bot., 3,* No. 1. 1927).

Anderson, A. P., A new *Tilletia* parasitic on *Oryza sativa* Linn. *Bot. Gaz., 27,* 467-72, 1889.

Baker, C. P., Additional notes on Philippine plant diseases. *Phil. Agri. & Forester, 5,* 73-78, 1916.

Bertus, L. S., *Report Myco. Div., Ceylon Deptt. Agri. Tech Rept. for 1928, 1929.*

Briosi, G. & Cavera, F., I. Funghi parasiti plante cultivate od utili. Fasch. I. *Pavia, 1886.*

Bryce, G., *Report on the work of the Botanical and Mycological Division. Ceylon Deptt. Agri., C13-C15,* 1920.

Butler, E. J., Diseases of Rice. II. *Agri. Res. Inst., Pusa Bull., 34,* 1913; Fungi and diseases in Plants. Calcutta VI-547 pp., 206 figs., 1918.

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Butler, E. J. & Bisby, G. R., The fungi of India. *Imp. Counc. Agri. Res. Pusa, Sci. Monograph, 1,* 1931.

Cattaneo, A., Sullo *Sclerotium oryzae*, Nuovo parassita vegetale. R. *1st Lombardo Sci. e Let Rend.* (2), *9,* 801-07, 1876; Contributo Allo Studio Dei Miceti Che Nascono Sulle Plantecelle Di Riso. *Arch. Lab. Bot. Crittogamica R. Univ. Pavia, 2-3,* 115-28, 1879.

Conner, A. B., Black kernel and white tip of rice. *Texas Agri. Expt. Stat., Bull., 584,* 14 pp., 1940.

Copeland, E. Bengham, Rice. IX-344 pp. Illus. London, 1924.

Cralley, E. M. & Tullis, E. C. ,Rice disease investigations Stem rot. *Ark. Agri. Expt. Stat., Bull., 312,* 1934; A comparison of *Leptosphaeria Salvini* and *Helminthosporium Sigmoideum Irregulare*. *J. Agri. Res., 51,* 341-48, 1935; Effect of seed treatments on seedling emergence, severity of seedling blight and yield of rice. *Arkans. Agri. Expt. Stat., Bull., 345,* 1-24, 1937.

Dastur, J. F., 'Pan-sukh' disease of rice in Central Provinces. *Agri. & Livestock in India, 7,* 509-11, 1937.

Dodoff, D. N. & Kovacchvski, J., "Preliminary study of the blast disease of rice in Bulgaria. *Scit. Transc. Bulgari. Agri. Soc., Sofia, 25,* 61." (English summary). 1930. (Abs. *Rev. App. Myco., 10,* 269-70, 1931).

Douglas, Charles E., Rice cultivation and preparation. 142 pp., frontispiece, 5 figs.

Duggar, B. M. & Stewart, F. C., The sterile fungus *Rhizoctinia* as a cause of plant disease in America. *Cornell. Agri. Expt. Stat., Bull, 186,* 51-76, 1901.

Edgerton, C. W., Rice. *U. S. Deptt. Agri. Bur. Plant. Indus. Plant Disease Bull.* (Mimeographed), *4,* 1920.

Farneti, R., Sopra il 'brusone' del riso. *Atti. Inst. Botan. dell Univ. di Pavia., 18,* 109, 1921 (Abs. *Rev App. Myco., 1,* 343, 1922).

Ferraris, Teodora, 'Brusone' del riso. ela *"Piricularia oryzae"*. Br. e. cav. *Nola Preliminare. Malpighia, 27,* 129-62, 1903.

Fukushi, T., On the intercellular bodies associated with the dwarf disease of rice plant. *Trans. Sappora Nat. Hist. Soc., 9,* 35-41, 1931; Transmission of the virus through the eggs of an insect vector. *Proc. Imp. Acad. Sci. Tokyo, 9,* 457-60, 1933.

Fulton ,H. R., Diseases affecting the rice in Louisiana. Lou. *Agri. Expt. Stat., Bull., 105,* 1908.

Garovagho, Santo, Del 'bursone' o carolo del riso. *Arch. Trien. d. Lab. Pavia., 1,* 173-202, 1874.

Haskell, R. J. & Diehl, W. W., False smut of maize, *Ustilaginoidea. Phytopath., 19,* 589-92, 1929.

Hemmi, T. & Seto, E., Experiments relating to the stimulating action by the casual fungus of the 'bakanae' disease of rice. (Preliminary Report). *Proc. Imp. Acad. Tokyo, 4,* 181-183, 1928.

Hemmi, T. & Yokogi, K., Studies on *Sclerotium* diseases of the rice plant I. *Agri. and Horti., 2,* 9-10, 1927. (Japanese, with English summary); Expt. studies on the pathogenicity of certain fungi on rice seedlings. *Mem. Coll. Agri. Imp. Univ. Tokyo, 7,* 1-22, 1928.

Hori, S., (Leaf blight of Rice plant). *Bull. Cent. Agri. Expt. Stat. Tokyo, 18,* 67-84 (In Japanese), 1901.

Ito, S. & Karibayashi, K., Production of the ascigerous stage in the culture of *Helminthosporium oryzae*. *Ann. Rept. Phytopath. Soc. Japan., 2,* 1-8, 1927.

Karibayashi, K., Studies on overwintering, primary infection and control of rice blast fungus, *Piricularia oryzae*. *Ann. Rept. Phytopath. Soc., Japan., 2,* 99-117, 1928. (Japanese with English summary).

Kawakami, T., 'Imochi''-disease of rice. *Journ. Sapparo. Agri. Soc., 2,* 1-49, 1901.

Kuwana, S. I., Important disease of rice crop in Japan. *Pacific Sci. Cong. Proc., 5,* 203-07, 1929, 1930.

Luthra, J. C. & Sattar, A., Some studies on the sclerotial diseases of rice in the Punjab. *Indian J. Agri. Sci., 5,* 973-984, 1936.

Martin, A. L., Possible cause of black kernels in rice, *Plant Disease Reporter, 23,* 83-84, 1939; Rice straw stacks as a source of infection of black kernel disease *Plant Disease Reporter, 23,* 247-49, 1930; The effect of Magnesium and Calcium on 'White tip' of rice. *Amer. J. Bot., 26,* 846-52, 1939.

Masse, G., A revision of the genus *Tilletia*. *Kew Bull.,* 146, 1899.

Matsuura, I., Comparative studies of four *Hypomycetes* pathogenic to rice seedlings. *Jour. Microbio. Soc., 21,* 1851-72, 1927 (In Japanese). (Abs. in *Japan. Jour. Bot. 3,* 93, 1927).

McRae, W., Notes on South Indian Fungi. *Madras Agri. Deptt. Year Book,* 108-11, 1917; Blast of paddy. *Agri. Jour. India, 14,* 65-70, 1919; Report of the Imperial Mycologist. *Agri. Res. Inst., Pusa, Sci. Reports, 1921-22,* 44-50, 1922.

Melchers, L. E., Diseases of cereal and forage crops in the United States in 1924. *U. S. Deptt. Agri. Bur. Plant Indus., Plant Disease Survey Bull. Sup., 10,* 107-188, 1924.

Metcalf, H., A preliminary report on the blast of rice, with notes on other rice disease. *S. C. Agri. Expt. Station Bull.,* 121, 1906; The pathology of the rice plant. *Science* (*N.S.*) *25,* 264-65, 1907; The present status of rice blast. *Science* (*N.S.*), *29,* 911, 1909; A preliminary report on the blast of rice. *S. C. Agri. Expt. Stat. Bull.,* 121, 1926.

Miyake, I., Studien Uber Die Pilze Der Reispflanze in Japan. *J. Collg. Agri., Imp. Univ. Tokyo, 2,* 237-76, 1910.

Mundkur, B. B., Parasitism of *Sclerotium oryzae*. *Calt. Ind. J. Agri. Sci., 5,* 393-414, 1935.

Nakata, K., *Sokumoisu Byogai Zuten* (Illustrated crop diseases), Tokyo, 1934.

Nishikado, Y., Studies on the rice blast fungus. *Ber. Ohara. Inst. Landw. Forsch., 1,* 171-218, 1917; Studies on the rice blast disease. *Japan. Jour. Bot., 3,* 239-44, 1927.

Nishikado, Y. and Miyake, C., Treatment of rice seeds for helminthosporiose. *Ber. Ohara Inst. Landw. Forsch., 1,* 543, 1920; Studies on the Helminthosporiose of rice plant. *Ber. Ohara Inst. Landw. Forsch., 2,* 133-195, 1922.

Oefemia, G. O., The *Helminthosporium* disease of rice occurring in the Southern United States and in the Philippines. *Amer. Jour. Bot., 11,* 385-408, 1924; The relationship of soil temperature to germination of certain Philippine upland and lowland varieties of rice and infection by the *Helminthosporium* disease. *Amer. Jour. Bot., 11,* 437-460, 1924.

Park, M., Report on diseases of plants in Ceylon during 1929. *Ceylon Deptt. Agri. Tech. Report, Mycol. Dici., 1929,* pp. 1-6, 1930.

Park, M. & Bertus, L. S., Sclerotial diseases of rice in Ceylon, IV. *Ann. Roy. Bot. Garden, Peradeniya, 11,* 343-59, 1932.

Pereira, De. B. E., *Sclerotium* disease of rice. *Phili. Agrist., 10,* 331-45, 1922.

Polo, Marcario A., *Rhizoctonia* disease of rice. *Phili Agrist., 25,* 361-77, 1926.

Reinking, Otto A., Philippine economic plant diseases. *Phili. J. Sci., Section A, 13,* 165-274, 1918.

Reports of the Mycologist to the Government of Madras from 1920 onwards, Madras (India).

Reyes, G. M., The stem-rot (Sclerotial Disease) of irrigated rice. *Phili. Bur. Agri. Circ., 227,* 1928; A preliminary report on the stem-rot of rice. *Phili. Agri. Rev., 22,* 213-31, 1929; New or little known rice diseases occurring in the Philippines. *Phili. J. Agri., 5,* 123-41, 1934; Rice hybrids *versus* stem-rot disease. *Phili. J. Agri.,*

7, 413-17, 1936; Disease resistant rice hybrids produced superior yields in commercial trials. *Phili. J. Agri., 8*, 417-23, 1937.

Rosen, H. R. & Elliot, J. A., Pathogenecity of *Ophiobolus cariceti* in its relationship to weakened plants. *J. Agri. Res., 25*, 351-58, 1923.

Saha, J. C., Effect of seed treatments on the germination of paddy *Madras Agri. Journ., 31*, 351-52, 1943.

Sakurai, M., On the *Sclerotium* diseases of rice plant. *Ehime Agri. Expt. Stat. Publ.* No. 8, pp. 60, 1917, (In Japanese).

Sawada, K., Rice blast disease and manuring. *Agri. Rept. Formosa, 35*, 22-31, 1940.

Sci. Reprt. Agri. Res. Institute, Pusa, pp. 44-74, 1921-22.

Sen, A. T., 'Myitpo' disease of paddy. *Proc. Indian Sci. Cong.*, 262, 1941.

Seto, F., Studies on the 'bakanae' disease of rice plant. I. A consideration of occurrence of the 'bakanae' disease and the 'bakanae' phenomenon. *Ann. Phytopath. Soc. Japan., 2*, 118-39, 1928 (Japanese with English summary).

Shaw, F. J. F., Morphology and parasitism of *Rhizoctonia*. *Mem. Deptt. Agri., India.*, 4, 1912; A sclerotial disease of rice. *Mem. Deptt. Agri., India*, Bot. Series, *6*, 11-23, 1913; A diseased condition of rice. *Agri. J. India, 17*, 152-54, 1922.

Sundararaman, S., *Helminthosporium* disease of rice. *Agri. Res. Inst., Pusa, Bull., 128*, 1922.

Suzuki, H., Studies on the influence of some environmental factors on the susceptibility of the rice plant to blast and *Helminthosporium* diseases and on the anatomical characters of the plant; influence in differences in soil moisture. *J. Agri. Coll. Tokyo, 13*, 45-108, 1934; Studies on the influence of some environmental factors on the susceptibility of the rice plant to blast and *Helminthosporium* diseases and on the anatomical characters of the plant; influence in differences in soil moisture and the amount of nitrogen fertilizer given. *J. Coll. Agri. Tokyo, 13*, 235-331, 1935; Studies on the relation between the anatomical characters of rice plant and its susceptibility to blast disease. *J. Coll. Agri. Tokyo, 14*, 181-264, 1937.

Takahashi, Y., On *Ustilago virens* Cooke and a new species of *Tilletia* parasitic on the rice plant. *Tokyo Bot. Magaz., 10*, 16, 1896.

Takami, N., Stunt disease of rice and *Nephotettix apicalis* M. *J. Agri. Soc., Japan, 241*, 22-30, 1901.

Tanaka, T., Japanese Fungi. Notes & Translations, XI. *Mycologia, 14*, 81-89, 1922.

Taubenhaus, J. J., Rice diseases. In *50th Ann. Rept. Tex. Agri. Expt. Stat.*, 114-15, 1937.

Taubenhaus, J. J., Altstatt, G. E. and Wyche, R. H., Black kernel of rice. In *48th Ann. Rept. Tex. Agri. Expt. Stat.*, 94, 1935.

Taubenhaus, J. J. and Wyche, R. H., Rice diseases. In *49th Ann. Rept. Texas Agri. Expt. Stat.*, 109-11, 1936.

Teodoro, N. G. and Bogayong, J. R., Rice diseases and their control. *Philip. Agri. Rev., 19*, 237-41, 1926.

Thomas, K. M., Some aspects of the control of blast disease of paddy. *Madras Agri. Journ., 18*, 9, 1931; A new paddy disease in Madras. *Madras Agri. Journ., 19*, 3, 1931.

Thompstone, E. and Sawyer, V. M., The 'Gowabo' disease of paddy. *Burma Deptt. Agri. Bull., 16*, 12, 1920.

Tisdale, W. H., Two *Sclerotium disease of rice*. *Journ. Agri. Res., 21*, 649-58, 1921; Seedling blight and stackburn of rice and the hot-water seed treatment. *U. S. Agri. Bull., 1116*, 11, 1922.

Tisdale, W. H. and Jenkins, J. W., Straight head of rice and its control. *U. S. Deptt. Agri., Farmer's Bull., 1212*, 1-16, 1921.

Tullis, E. C., *Helminthosporium sigmoideum*, the conidial stage of *S. oryzae* (Abs.) *Phytopath., 22*, 28, 1932, *Ophiobolus oryzus*. The cause of a rice disease in Arakansas. *Journ. Agri. Res., 46*, 799-806, 1933; *Leptosphaeria salvani*, the ascigerous stage of *Helminthosporium sigmoideum* and *Sclerotium oryzae*. *J. Agri Res., 47*, 675-687, 1933; *Trichoderma* sheath spot of rice *Phytopath., 24*, 1374-77, 1934; Leaf smut of rice in the United States. *Phytopath., 24*, 1386, 1934; Histological studies of rice leaves infected with *Helminthosporium oryzae*. *J. Agri. Res., 50*, 81-90, 1936; Fungi isolated from discoloured rice kernels. *U. S. Agri. Tech. Bull., 540*, 1-11, 1936; *Cercospera oryzae* on rice in the United States. *Phytopath., 27*, 1005-8, 1937.

Tullis, E. C., Jones, J. W. and Davis, L. L., The occurrence of stem-rot of rice in California. *Phytopath., 24*, 1017, 1934.

Tullis, E. C., Jones, J. W., Davis, L. L. and others, Control of stem-rot by burning stubbles. *Phytopath., 13*, 218-19, 1933.

Titell, Z., (An experiment in the control of spot disease of rice). *Zeitsh. für Pflanzenkrankh and Pflanzenschutz, 38*, 279-84, 1928) (Abs. *Rev. Appl. Myco., 8*, 124-25, 1929

Van der Elst, P., Mentek-disease of rice. *Pacific Sci. Cong. Proc. 1929, 5*, 329-31, 1930.

Van Hall, C. J., "Diseases and pests of cultivated plants in the Dutch East Indies in 1920." *Meded. Van. het Inst. Voor Plantenziekten., 46*, 50, 1921. (Eng. Ver. *Rev. Appl. Mycol., 1*, 18, 1921).

Vincens, F., (Observations on *Sclerotium oryzae* made in Cochin-China). *Rev. Path. Veg. etc. Ent. Agri., 10*, 112-31, 1923. (Abs. *Rev. Appl. Myco., 3*, 174, 1924)

Willis, L. G. and Garrer, J. O., Influence on some nitrogen fertilizers on the development of chlorosis in rice. *J. Agri. Res., 24*, 621-40, 1923.

Young, V. H., Observation on the stem-rot of rice caused by *Sclerotium oryzae*. Catt. *Rice J., 29*, 11-12, 1926.

PROTOZOA IN RELATION TO SEWAGE PURIFICATION

S. C. PILLAI and V. SUBRAHMANYAN,

DEPARTMENT OF BIOCHEMISTRY, INDIAN INSTITUTE OF SCIENCE, BANGALORE

IN a previous communication[1], some direct evidence on the outstanding rôle of protozoa in the purification of sewage was adduced. It was also clearly shown that the part played by bacteria in the purification process is relatively inconsiderable. The object of the present note is to draw attention to the more important forms of protozoa that are responsible for sewage purification in all aerobic systems, including soil, as revealed by our studies extending over a period of seven years.

In September, 1938, when a new activated sludge installation (dealing with the sewage from a population of 8,000—10,000) was taken into operation at Cossipore, Calcutta, a very significant observation was made bearing on the special forms of protozoa in the flocculation of sewage and formation of activated sludge: *viz.*, that the production of an effective sludge and its characteristic clotting and clarifying action was closely correlated with the development and dominance of Vorticellids, more especially the colonial forms, although in the earlier stages of the working of the new plant the protozoan fauna included a number of forms, such as the species of *Amoeba, Euglena, Gonostomum, Colpoda, Acineta, Stylonichia* and *Paramecium*.[2] Experiments carried out with the species of *Colpoda, Stylonichia, Paramecium, Vorticella* and *Epistylis* isolated from the sludge showed that *Epistylis* was the most efficient among the protozoa in the flocculation and oxidation processes. Comparing on a numerical basis, *Epistylis* was found twice as efficient as the simple *Vorticella*, while the other forms of protozoa were less efficient. The amounts of sludge formed by Epistylis, Vorticella, Paramecium, Stylonichia, and Colpoda were 5·2, 2·5, 2·0, 1·8 and 1·2 per cents respectively; the corresponding amounts of sludge produced by the associated bacteria singly and collectively were 0·4 to 0·5 and 0·8 per cents respectively. The sludge forming property of the different forms also served to denote the degree of purity of the effluents produced.[3, 4, 5]

The daily observations carried out by us during the last seven years (with the exception of a few days) on the protozoan population of activated sludge have clearly shown that the most important forms are the colonial Vorticellids, more especially the genus, *Epistylis* of which some nine species have been isolated. The logarithm of the Epistylis count closely follows the efficiency of the purification process, as measured by the purity of effluents and the quality of sludges produced. Recent observations at Huddersfield would further confirm the special significance of Vorticella.[6]

The following observations would show that the high nitrogen content and the fertilizing action of activated sludge is largely due to its protozoan content.

DISTRIBUTION OF FERTILIZING INGREDIENTS IN THE PROTOZOA AND ACTIVATED SLUDGE (RESULTS OF ANALYSIS EXPRESSED IN PERCENTAGE ON OVEN DRY BASIS)

	Organic matter (loss on ignition)	Total nitrogen (N)	Total phosphoric acid (P_2O_5)
Washed cells* Epistylis	94·50	9·86	1·38
Activated sludge ..	72·84		2·67

Pot trials with the protozoan material and activated sludge (on equal nitrogen basis) were carried out with tomatoes and French beans. The growth of plants and yields obtained from the two series were comparable. The yields from the protozoan series were in fact a little higher than those from the activated sludge.

It has already been reported that about 80 per cent of the total nitrification in activated sludge takes place in presence of Epistylis.[7] The extent of nitrification by the bacteria in activated sludge (a number of bacterial forms showing some nitrifying power have been isolated on nutrient agar) is comparatively very little. Further observations have shown that there is a definite relationship between the flocculation of sewage and nitrification in the sludge formed, both the processes being profoundly influenced by the protozoa. During flocculation, the protozoan numbers steadily increase and attain their maximum at the clotting out stage, and it is at this stage that the percentage of nitrogen in the sludge is highest. As the protozoa actively grow they secrete a slimy or mucilaginous substance, but it has not so far been possible to demonstrate any direct relation between the slime and the flocculating action associated with the protozoa; if the protozoa are inactivated or killed by heat or chemicals, the production of the slime or mucilage is also adversely affected and together with it the flocculating action. Normally,

* Fluffy masses of Epistylis sp. originally taken from the sides of the aeration tanks and washed repeatedly with ammonia-free distilled water.

after flocculation, there is a fall in the numbers of active protozoa and nitrification is then actively promoted. When air is bubbled through suspensions of washed Epistylis in ammonia-free distilled water, nitrite and nitrite are formed in quantities, which are comparable (on the basis of protozoan numbers) to those produced in activated sludge. Parallel studies with treated protozoa (well crushed with glass powder or heated to about 50°C. so as to inactivate or kill them) also show that nitrification is not impaired by such treatments.

The main factors governing the normal development and activity of the protozoa are adequate supplies of air and fresh organic matter (as represented by raw sewage). Under conditions of inadequate aeration, the protozoa die and the sludge becomes filled with gases, so that 'bulking' is caused.[8] If, on the other hand, the air supply is disproportionately excessive and the supply of organic matter is insufficient, the protozoan cells begin to disintegrate ; the sludge becomes dark brown or blackish, showing a 'burnt' condition. This phenomenon is traceable to an oxidase (catechol oxidase) present in the protozoa and released through the disintegration of the cells.

Thus, in the light of the protozoan activity, practically all the properties of activated sludge, such as its flocculating, nitrifying and fertilizing action, may be adequately explained. The phenomena of 'bulking' and the formation of 'burnt' sludge are also intimately connected with the life of the protozoa. The problem of dewatering activated sludge is also closely linked with the physical condition of the protozoan cells which are extremely slimy and mucus-like and hold large quantities of water.

It has also been observed that the efficiency of other aerobic systems of Sewage treatment, such as the simplex surface aeration plants, depends upon the extent to which the special forms of protozoa develop.

In the sludges formed under anaerobic conditions, such as the septic sludge, the more important protozoa exist in the form of cysts or spores. In some of the other older methods of sewage treatment, at certain stages of the purification process, some of these protozoa naturally develop. Before the advent of the activated sludge process, at Manchester the process adopted for treating the sewage was sedimentation, followed by further purification of the effluent on first and second 'contact bacteria beds'. In the effluents from the Withington Works as also at the base of a secondary percolating filter at Davyhulme dealing with the effluent from primary contact beds, considerable growths of *Carchesium Lachmanni* and one of the higher bacteria, *viz.*, *Leptomitus lacteus* were noticed (Carchesium abounding chiefly in warm weather and Leptomitus in the winter months).[9] The experiments carried out at the Lawrence Experiment Station prior to the development of the Activated Sludge process by Fowler and his associates are also of special interest in this connection.[10] When an aerating tank containing slabs of slate was put into operation, it was observed that the slate and the sides of the tank became covered with a compact brown growth and that this growth collected not only the suspended matters but also a large portion of the colloids, so that, after a few hours of treatment the sewage became free from both. A repetition of the original experiment would probably show that the compact brown growth was predominantly due to protozoa.

We have traced the origin of the Vorticellids in the sewage tanks and have found that they are derived from soil. The simple and colonial Vorticellids are widely distributed in nature—in polluted and stagnant waters, tanks, rivers, canals, ponds, pools, paddy fields, etc. Samples of water from these sources containing the large ciliates, particularly the Vorticellids (the development of which is largely determined by the amount of organic matter and the extent of air supply), have invariably shown considerable amounts of nitrite and nitrate. In dry soil, the vorticellids exist in the form of cysts, and under conditions of waterlogging they become active. In fact, since the invention of the microscope, the very first protozoa described by Leeuwenhoek[11] was a species of *Vorticella*, which he had seen in standing rain-water in 1675.

Even under conditions of land treatment of sewage, if provision for proper aeration is made by means of suitable drains etc., the protozoa naturally become active and cause purification. In fact, in certain sewage farms in South India (*e.g.*, Madura) maintained under such proper conditions, a number of species of vorticellids (more especially of *Epistylis* and *Carchesium*) have been found to flourish throughout the year to purify the sewage and to produce very satisfactory effluents comparable to those from the activated sludge tanks.[12] Along with these protozoa have been found to thrive a variety of higher forms of life, such as worms, insect larvae and fish life (some of them well-known species of edible fish). The natural development of the different forms of life in the sewage effluent channels provides an excellent illustration of the nitrogen cycle in which the newly discovered link of protozoa appears to be of basic importance.

It may be concluded from the above observations that the vorticellids, more especially the colonial forms, are most important in the purification of sewage in all aerobic systems, including well aerated soils. The observations are of further considerable

importance in introducing an entirely new outlook with regard to the rôle of protozoa in nature.*

References

[1] Pillai, S. C. & Subrahmanyan, V., *Nature*, *154*, 179, 1944.
[2] Pillai, S. C., *Report on the activated sludge plant at Cossipore, Calcutta* (dated 30th September, 1938) to Dr. G. J. Fowler, Representative of Messrs. Activated Sludge Ltd., London.
[3] [4] Pillai, S. C., *Current Science*, *10*, 84, 1941. *11*, 437, 1942.
Pillai, S. C., *Indian Medical Gazette*, *77*, 118, 1942.
[5] Reynoldson, T. B., *Nature*, *149*, 608, 1942.
Pillai, S. C. & Subrahmanyan, V., *Nature*, *150*, 525, 1942.
Pillai, S. C. & Subrahmanyan, V., SCIENCE AND CULTURE, *8*, 376, 1943.
[6] Fowler, G. J., *Journ. Roy. San. Inst.*, *30*, 513, 1909; *Ann. Rep. City Manchester Rivers Dept.*, Part II, p. 7, 1910.
[7] Clark, H. W. & Gage, S. DeM., *44th Ann. Rep. State Board of Health of Mass.*, p. 275, 1912.
[8] Leeuwenhoek, *Philos. Trans.*, *12*, No. 133, p. 821, 1677.
[9] Pillai, S. C., SCIENCE AND CULTURE, *10*, 398, 1945.

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Notes and News

U.N.R.R.A. MISSION IN INDIA

THE recent arrival in India of the United Nations Relief and Rehabilitation Administration (U.N.R.R.A.) Mission has been announced in the Press. The object of the Mission's visit to India, as explained by Mr Francis B. Sayre, head of the Mission and Diplomatic Adviser of the U.N.R.R.A., at a press conference, is to ascertain, after consultation with Government officials, the maximum help India can render towards meeting human needs in the liberated territories without injury to her own people or to her own economy. Mr Sayre was very kind to have assured the Indian public that the Mission had no thought of taking from India goods or foodstuffs badly needed by the Indian people themselves. She will be required to supply such surplus goods as she produces beyond her needs, and further, in the manner of their procurement, the Government of India shall follow ordinary and normal channels.

We are not aware what items have been proposed for inclusion in the list of supply from India to the liberated countries of Europe. That cloth may form an important item in the list now appears almost definite, if the statement given at Karachi by a member of the Australian delegation to U.N.R.R.A., recently passing through Karachi on its way to Europe, is to be believed. The ways with our Government have always been an enigma to us. Acute shortage of cloth is reported from Bengal and other provinces of India, and there have been during recent months several cases of open demonstrations of large number of naked and semi-naked men and women in many district and muffusil towns. A number of suicide cases, involving mostly women who could not come out in the open for want of clothes which appeared in the daily press, leave no doubt as to the extremely serious nature of the problem of cloth supply. So far slightest improvement in the cloth situation has not been reported from any part of the country. It is very strange indeed that supply of cloth from India as a surplus good should be suggested at a time when acute cloth famine is driving exasparated and harassed people to commit suicide as the last solution.

We are full of sympathy for the war weary and oppressed peoples of Europe, long victims of Nazi tyranny. They are urgently in need of relief on an extensive scale, and the impelling call of humanity requires that all countries, big or small, should rush whatever help they are capable of rendering. The noble nature of the task of pooling supplies from all the united nations and organizing relief, with which the U.N.R.R.A. has been entrusted, cannot be called in question for a moment. But the same organization, it might be recalled, at first refused, and then hesitated, to have anything to do with the Bengal Famine which took a toll of human lives far in excess of what have been killed in the whole European theatre of war. Legal question as to whether such a famine could come within the scope of the U.N.R.R.A., and not loss of valuable human lives in thousands through starvation, was foremost in the thoughts of the Administration when it was approached for succour and relief.

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS

WE are much indebted to the National Institute of Sciences, particularly to Mr D. N. Wadia, Presi-

dent of the Institute, for having kindly informed us of an offer of a number of Research Fellowships by the Imperial Chemical Industries to the National Institute of Sciences, India. A sum of Rs. 3,36,000 has been made available for Fellowships in chemistry, physics, and biology, to be created at Indian universities and institutions approved by the Council of the Institute, over a period of five to seven years. In his letter to the President of the Institute, Lord Mc Gowan, Chairman of the Imperial Chemical Industries, explained the object which prompted the offer of Fellowships in the following words:

"The National Institute of Sciences is, we believe, destined to play in India a part similar to that which the Royal Society of London has performed for nearly three hundred years in leading the scientific progress of this country.

The Royal Society until recent years was hampered by lack of funds and provision for the maintenance of scientific workers. This difficulty was eventually overcome by the generosity of various benefactors, including Industrialists such as Mond and Messel.

We thought, therefore, that there could be no better way of encouraging the advance of science in India and with it the general prosperity of the country than by the offer of these Fellowships which under the wise administration of your Council will, we hope, lead to an augmentation of the distinguished successes in science already attained by so many of your fellow countrymen."

These lines breathe the same spirit and concern for the promotion of fundamental research as characterized the I. C. I.'s similar offer of eighty research fellowships at nine universities in Great Britain, reported in an earlier issue of this journal (SCIENCE AND CULTURE, Vol. X, No. 5). This time, by making the offer to Indian universities and institutes, the I.C.I. has given fitting recognition to the international character of science.

Following is the text of the document to the President of the National Institute of Sciences, indicating the terms of reference under which the Fellowships are created:

(1) Each fellowship to be worth 400 rupees per month and to be tenable in the first instance for two years, with a possibility of extension up to a total of three years. (It is assumed that half the fellowships will be extended for a third year).

(2) In addition there will be a grant for research expenses to be made to the fellowship holders according to their needs of special apparatus and materials. For this purpose the National Institute will have at their disposal an average of 600 rupees per annum for each fellowship.

(3) There will be a grant of 13,200 rupees per year to the National Institute for five years to enable them to pay for administration and the travelling expenses of such fellows of the Institute as may be selected to visit the fellowship holders at their Universities or Institutions.

The National Institute of Sciences is asked to administer the fund for the fellowships on the following principles:

(1) Appointment to and control of the fellowships to be made by the Council of the National Institute, acting on the advice of of a special research fellowships committee.

(2) This special research fellowships committee will represent various scientific fields and be drawn from various parts of India, so as to include any community, the overriding consideration for membership being scientific fitness therefor.

(3) The fellowships will be open to persons, irrespective of sex, race or religion, resident or domiciled in India (British India or the States) and under 35 years of age.

(4) The fellowships will be tenable at any University or Institution in India, approved by the Council of the National Institute.

(5) Fellows will be permitted to do a limited amount of approved teaching or demonstrating. This should not be more than six hours per week and it should be a condition that they are paid for this work by the Institution or University at its normal rates.

(6) The aim of the fellowships is to strengthen research in Indian Universities and Institutions, and it is hoped that the National Institute of Sciences will spread the research fellowships over them in accordance with this aim, but with the overriding consideration of the scientific suitability of the particular University or Institution.

ECLIPSE OF JULY 9

BRISK activities of professional and amateur astronomers were reported from the Scandinavian countries, the U.S.S.R., and the U.S.A. on the occasion of the solar eclipse of July 9. A total eclipse was observed from a narrow belt on the earth's surface, passing through Idaho and Montana in the U.S.A., Saskatchewan and Manitoba in Canada, Greenland, Norway, Sweden and Finland and lastly through many well-populated regions in the U.S.S.R. In Idaho, the eclipse started with the sun rise; midtotality occurred near noon at a place, called Scoresby Sound, on the east coast of Greenland, where the

duration of the eclipse was the longest (1 min. 16 sec.), as already calculated by the Nautical Almanac office of the U. S. Naval Observatory. In Turkistan, the sun set totally eclipsed. The total duration of the eclipse was about 2 hours and 27 minutes from the time the sun rose eclipsed in Idaho until it set eclipsed in Turkistan.

The maximum duration of totality, being only about 1 minute and 16 seconds, was much shorter than the duration of average total eclipses, which is between 2 to 3 minutes. The path of the eclipse was also narrower this time. But favourable weather conditions in July and the advantage of an extensive land area over which the path was due to pass made the occasion specially important for the study of solar problems during eclipse. Several astronomical parties were reported to have been organized in Norway, Sweden, U.S.S.R. and U.S.A. A number of problems outlined by Prof. Bertil Lindblad of the Stockholm Observatory were investigated. The results of investigation carried out by these parties are not yet to hand.

SUPERNOVA IN CANES VENATICI

SKY AND TELESCOPE (June 1945) reports the discovery of a supernova in the constellation of Canes Venatici on April 6th and 7th by Mr M. L. Humason of the Mount Wilson Observatory. For the last three years, Mr Humason was trying to observe and photograph the Satellite spiral and Messier 51, the famous spiral nebula, without success. On the evening of April 6, while he was preparing to photograph the satellite, his attention was attracted to a faint star, not known before, and he suspected it to be a new star. He at once settled his doubts by obtaining its spectrum the following evening and confirmed the existence of strong bands in the red region, characteristic of supernovae about 65 days past their maximum brilliancy. On April 12, its photographic and photovisual magnitudes were 16·0 and 14·0 respectively, its estimated photographic maximum being 11·0.

It was a chance discovery. The star was fading so rapidly that a few weeks later the observer would have completely missed it. Mr Humason stated he was lucky enough to have had M 51 down on his observing programme. The special significance attaching to its discovery may be realized from the fact that supernova appears in a spiral nebula once in every 400 years.

POPULATION IN INDIA AND U. K.

SIR Jeremy Raisman, late Finance Member of the Government of India, in a statement to the Reuter's Special Correspondent in London, said that regulation of the Indian population was of greater importance than planning to house, clothe and feed those already living. Population in India is increasing at the rate of 50,00,00 annually (and not 10,00,000 as stated by Sir Jeremy) and it is impossible to put into operation plans for better feeding and housing. He has suggested the establishment of a net-work of clinics throughout the country at which Indian men and women can be trained in the scientific methods of birth regulation and where they can receive advice on this subject. Such a social service should be sponsored by the Government of India, but Sir Jeremy was very doubtful as to whether any Government would be willing to face the criticism that would arise from religious and social organizations.

As a contrast to this, Britain's alarming decline in birth rate is revealed by the Royal Commission on population appointed last year. In 1939, birth rate in Britain reached its lowest level of 14·9 per 1,000. An increase in the rate is noticed from 1942, and while it is expected that it will continue to rise in the next five years, 'there will have to be definite measures for encouraging larger families'. Couples in Britain, however, will not have larger families without being reasonably certain that the children will have a good education and decent living. Grant of family allowances, improved health and child welfare facilities, priority housing for large families, and similar other social services are the remedies suggested by the Population Commission in Britain.

Britain's population has been falling steadily over the last 75 years and if the population trends are not reversed within the next 50 years, she would no longer rank as a first class military and economic power.

The problem of population is thus a vexed and a controversial subject, and it cannot be lightly dismissed with by those concerned with planning for better health and nutrition of India's population.

The Malthusian thesis *viz.*, that whereas population increases by geometrical progression, food production can increase only by arithmetical progression, has been falsified. The growth of population in Western countries has slackened, but the application of scientific methods to agriculture has enormously increased food production. Experts in India would find it difficult to share Sir Jeremy's conclusions.

VILLAGE INDUSTRIALIZATION

THE All-India Manufacturers' Organization has recently issued a pamphlet entitled 'Village Industrialization' by Sir M. Visvesvaraya, President of the Organization. In this pamphlet, Sir Visvesvaraya has come forward with a scheme for developing industries in the rural areas by suitably group-

ing villages. The author believes that, in any programme of rural uplift, development of industries should occupy the foremost place. This should not be interpreted as any reflection upon the importance of progress in agriculture, communications or other developments ; industries are suggested first 'because whatever gainful activities have to be promoted will require money and talent', which planned industrialization can alone create.

Two basic measures have been suggested. The first measure consists in grouping villages together so that the area and population of each group may form a convenient working unit. On an average, ten villages with a population of about 15,000, should form such a unit, and each village group should be treated as an independent self-developing area.

The second measure is to constitute a committee of about a dozen representative citizens in each unit, to be elected annually by the population of the village group, and having a term of service not exceeding three years. The Committee will be responsible for the industrial progress of the village group, and its various subsidiary activities shall include supervision and regulation of agricultural production, conservation of a couple of years' food supply, education, both elementary and vocational, etc.

The scheme places great emphasis on the collection and maintenance of statistics. It proposes to maintain statistics of income and publish annually a reliable estimate of the *per capita* income. It further seeks to increase income of the rural population, double production from agriculture and industries in five to seven years, and to ensure two years' food supply. But the fundamental aim of the plan is to instil in the leaders and the more intelligent sections of the population a spirit of enterprise and social service, now almost rare qualities among such folk.

The scheme is reported to be working on an experimental basis in a number of places of the country. The proposition for rural uplift through village industrialization rests on sound principle, and it is very desirable that the scheme prepared by no less an expert than Sir Visvesvaraya should be closely studied and put into operation.

INDIAN INSTITUTE OF SCIENCE

PRESIDING over the Eighth Annual Meeting of the Court of the Indian Institute of Science, Bangalore, on July 2 last, Sir M. Visvesvaraya said, "The object of this Institute, according to responsible opinion recorded in the past, was to help industries by providing them with the applied research which they need". But for a long time attention given to industrial research was scanty, and it is only within the past four years that such work has been carried out mainly for war work and under instructions from the Supply Department.

In 1939, the Institute had four departments *viz.*, General and Applied Chemistry, Bio-chemistry, Physics and Electrical Technology. The department of Cosmic Ray was added in 1942 and a department of Aeronautical Engineering started in 1943. During the current year, work in the departments of metallurgy, automobile engineering and internal combustion engines is expected to commence.

The creation of a new section *viz.*, Industrial Relations Department, for contacting research with industries is suggested by Sir M. Visvesvaraya. The Joint Committee of the Court and Council already in existence has helped to give industrial research greater prominence in the normal working of the Institute, consistent with the objects of the original founder.

Under research in fundamental science during the year under review attention is drawn to the claims made by Sir C. V. Raman and Dr R. S. Krishnan 'in the discovery of the Raman spectra of the second order in diamonds, quartz, calcite and other crystals'. In the Cosmic Ray unit, Dr Bhabha carried out experiments for measuring intensities of mesons capable of penetrating different thicknesses of lead up to an altitude of 32,000 ft. It is stated that six different pieces of apparatus were sent up, the total weight of which was no less than half a ton, in a liberator bomber supplied by the courtesy of the United States Army Air Force from the Hindusthan Aircraft Factory.

The receipts and expenditure in 1944-45 amounted to Rs. 7·21 lakhs (excluding grants from outside authorities for special services) and Rs. 8·12 lakhs respectively. This shows that the Institute has been spending more than it is receiving. Of the amount spent, approximately one-third is on technological instruction, one-third on industrial research and the remaining third on all the other classes of work. If the affairs of the Institute is to be placed on a satisfactory footing, a capital grant of Rs. 50 lakhs spread over for five years, with an additional recurring grant of Rs. 5 lakhs per annum, is needed.

A Committee has been appointed with Prof. M. N. Saha as Chairman, and Mr M. S. Thacker of the Calcutta Electric Supply Corporation, Mr H. M. Mathews, the Electrical Commissioner of the Government of India, and Mr W. L. Voorduin, Member of the Central Power Board, to draw up a syllabus and estimates for a post-graduate course in all branches of power engineering.

Sir Visvesvaraya recognizes that an effort to make a very large proportion of the student population familiar with engineering research and with

machine tools and machinery will at present constitute the most important part of the nation building activity in India. Need of provision for research in heavy engineering and machine design in the future work of the institute is also emphasized.

MICRO-WAVES IN LONG DISTANCE TRANSMISSION

THE American Telephone and Telegraph Company, according to a report of the *Science News Letter*, has recently undertaken to carry out elaborate tests to determine the efficiency and economy of micro-wave radio relay for long distance telephone transmission and for sound and television broadcast programmes. The advantages of reception in the micro-wave region of the radio spectrum are well-known. The reception is almost free from static or fading, and since the highly directive antennae can concentrate the energy in a narrow beam, the signal strength is considerably increased. Furthermore, the micro-waves do not travel much beyond the horizon and thus permit the same set of frequencies being used over and over again at alternate relay stations.

The company has planned to construct seven relay stations, consisting of transmitters and receivers connected to highly directive antenna systems. Radio waves will be picked up and amplified at each station and transmitted on to the next where the process will be duplicated until a terminal is reached. The terminal stations will be at New York and Boston. Sites for the relay stations, chosen for their elevation, will lie between 355 ft. to 1395 ft. above sea level.

The Company has already applied to the Federal Communications Commission to authorize the construction of the stations. If the experiments prove successful and suggest commercial exploitation of the new system, micro-wave method of transmission may eventually have to be connected with the existing system of transmission over wires and cables and will doubtless prove a valuable supplement.

CENTRAL LIVESTOCK RESEARCH AND CATTLE BREEDING STATION IN BENGAL

A SCHEME for the establishment of a central livestock research-cum-breeding station at Haringhata, about 35 miles north-east of Calcutta, has been approved by the Bengal Government, on the recommendations of the three New Zealand experts who were invited by the authorities to review the deteriorating cattle position in the province. The scheme would involve acquisition of about 5,000 acres of land and a total expenditure of Rs. 54,00,000.

The proposed institution will investigate local problems of breeding and produce pedigree bulls for supply throughout the province to improve the cattle.

It is to be noted that breeding is not the only essential part of a programme for the improvement of cattle. Proper feeding, feeding with green fodder, and climate are very important factors. The varied climatic and edaphic factors in Bengal necessitates the establishment of cattle breeding farms in representative parts of the province to evolve improved breeds suitable for each part. The Haringhata scheme is an essential first step to any effective plan for permanent improvement in the milk supply of the province.

RETIREMENT OF SIR CLAUDE INGLIS, Kt., C.I.E.

The retirement from Poona in March last of Sir Claude Inglis, Kt., C.I.E., B.A., B.A.I. (Hons.), M.Inst.C.E., M.Am., Soc. C.E., I.S.E., Director, Indian Waterways Experiment Station, marks the close of a gifted scientist's career in this country.

Sir Claude came out to India in 1909 and was appointed to Jamrao Canal in Sind (Bombay Presidency) from where he was soon transferred to the Bombay Deccan to introduce some of the Sind methods on the Godavari and Pravera Canals.

When the Special Irrigation District (later the Special Irrigation Division and then the Irrigation Research Division) was formed in 1916, Sir Claude was placed in charge of the new District to undertake soil surveys and investigate the cause of the damage and institute remedial measures on the water logging and salt efflorescence which had followed in the wake of canal irrigation in the Deccan.

A hydrodynamic research station first of its kind in India—was opened at Poona in 1920 and Sir Claude was appointed here to carry out research work on the control of irrigation water supplies on Deccan canals. In 1937, Sir Claude was appointed to the Directorship of this station established as a Central Station for the whole of India.

In 1943, Sir Claude served as a member of the Technical Committee appointed by the Government of India to advise on the short-term measure—in the interest of the war effort for the Damodar embankment. He was also appointed a member of the Damodar Flood Control Committee of the Bengal Government to advise on the permanent measures to control floods in the Damodar River and on the utility of the scheme for flood regulating reservoirs prepared by Mr C. Addams Williams and Mr E. L. Glass in 1929.

Sir Claude also served on several other Advisory Committees and was a member of the Central Board of Irrigation Research Committee since its inception.

He made notable contributions to the literature of engineering science, specially on the subjects of river physics, and, while presiding over the engineering section of the Indian Science Congress in 1941, delivered an address on "Hydro-dynamic Models as an aid to Engineering Skill".

Scientists in India will remember his services in the furtherance of the science of river engineering and for the establishment of the Indian Waterways Experiment Station at Poona.

With the retirement of Sir Claude Inglis, Rao Bahadur D. V. Joglekar has been appointed to officiate as Director, Indian Waterways Experiment Station, Poona.

LIVING FOSSILS

MANY common American trees *e.g.*, sycamore, oak, elm, willow, beech, tulip-tree and others, found in the cretaceous and that are practically unchanged to the present time, are referred to as "living fossils" by D. H. Campbell (*Science*, September 1, 1944). Such conservatism in the land plants is obvious when their fossil history is explored. Although fossil record in the southern continent is incomplete, there are strong evidences to suggest that the fossils are closely related to the existing species of the same area and that those of the temperate zones of North and South America are essentially different. This essential difference in the temperate flora of the two continents and the fact that most of the existing forms can be traced back to the end of the Mesozoic era is a strong confirmation of the recent theory of Du Toit that there were two primordial continents, Gondwana and Laurasia. According to him, the two primordial continents remained completely separated until the end of the Mesozoic, when Gondwana was divided into the present southern continents which drifted apart to their present positions, carrying with them many of the unchanged descendents of the original Gondwana flora. The existing remnants of the Gondwana flora occur in regions separated by vast expanses of the ocean.

According to Dr Campbell, Du Toit's theory of continental drift is the only plausible explanation of the present distribution of plants, specially in the southern hemisphere.

SCIENCE IN INDUSTRY

"GAMMEXANE"—A NEW BRITISH INSECTICIDE

THE fact that the supply of derris and pyrethrum is limited and their method of production is expensive led Imperial Chemical Industries to search for new chemicals easily synthesized and with as effective insecticidal properties as pyrethrins and rotenone. As a result of their investigations extending over a period of five years a powerful new insecticide has been found in benzene hexachloride. This compound "gammexane" (technically called 666) known since the day of Faraday (*Annalen der chemie*, 30, 2, 274) is the gamma isomer of benzene hexachloride $C_6H_6Cl_6$ and has been found to possess outstanding insecticidal properties. It is made by the additive chlorination of benzene in the presence of light (J. Meunier. *Compt. Rend 98*, 436 ; R. Schüpphaus. *Ber, 17*, 2256).

Although the physiological action of benzene, and the alterations which occur in its action when one or more hydrogen atoms are replaced by halogens, hydroxyl, nitro or amino group had been studied as early as 1891 (T. L. Burnton and J. T. Cash, *Proc. Roy. Soc. 49*, 311, 1891), it was only in 1942 that the insecticidal properties of benzene hexachloride were discovered in the course of the search for a substitute for derris. During the summer of 1943 some hundreds of tons of flea-beetle powder containing gamme..ane were used as insecticide and were found at least as effective as derris.

The next stage in the development originated in the observation that the activity of samples of crude benzene hexachloride varied and this led to the discovery that the isomers varied considerably in their activity. It was later found that the really active constituent is the gamma isomer which is present in the crude benzene hexachloride to the extent of 10-20%. (SCIENCE AND CULTURE, *10*, 544).

Various Isomers.—Meunier (*Compt. Rend 98*, 436, 1881) showed that benzene hexachloride contains two isomers, the alpha isomer having a melting point 157°C. and the beta isomer which had a much higher melting point. In 1912, T. Van Der Linden (*Ber 45*, 231, 1912), proved the existence of four isomers, having the following melting points.

Alpha isomer melting at 158°C., Beta melting over 200°C., Gamma at 112-113°C. and Delta from 129 to 132°C.

Stability.—Benzene hexachlorides are fairly stable. During the manufacturing processes they are exposed to the action of light and hot water. Even the continued exposure to atmosphere has no effect on them. Alkalis like lime water can remove from benzene hexachloride, hydrochloric acid with the formation of a mixture of isomers of trichlorobenzene. This action may also be brought about by mixing gammexane with dry lime. Chalk or ground lime stone at 60°C. either dry or in presence of water does not bring about dehydrochlorination of benzene-hexachloride.

Pharmacological action.—The results of the pharmacological action of the various isomers are summarized in the table given below. The specificity between isomerism and physiological action as illustrated by the different isomers is of interest.

Compound	Melting point	Qnty. per kilo of the body wt. of rat necessary to obtain a 50% kill.	Toxicity to gold fish
Alpha isomer	158°C.	1·7 gm.	Saturated soln. no action.
Beta ,,	Over 200°C.	No kills.	Saturated soln. no action.
Gamma ,,	112–113°C.	0·19 gm.	Toxic at one part per million of solution.
Delta ,,	129–132°C.	1·00 gm.	
The mixture of isomers		1·25	

Mode of application.—A substitute for ground derris is prepared in the form of a finely ground powder containing 20% of crude benzene hexachloride and 80% of gypsum. For use on crops the above was mixed with selected inert materials to give insecticidal powders. For use in solution gammexane is generally dissolved in methyl alcohol, xylene carbon tetrachloride, perchloroethylene and decahydronaphthalene. Solution containing 5% gammexane may be diluted for use with kerosene or other suitable oils. By using emulsifying agents concentrated solutions are prepared which with water give a stable emulsion suitable for use in the fields. Gammexane has been found to be very stable even at high temperatures enabling it to be applied as a fumigating agent by the use of volatilization processes.

Insecticidal properties.—To many insects and pests gammexane has been found to be highly toxic. It is decidedly effective against the migratory African locust, house cricket, cockroaches, louse, bed-bug, caterpillars, varieties of beetles, wasps, ants, mosquitoes, house fly, fleas, and host of others.

Gammexane is stated to be effective against an exceptionally wide range of insects. It is more effective in some cases than any other insecticides including even D.D.T.

The median lethal dose though varying considerably from pest to pest is generally lower than that for other insecticides. Investigations show that gammexane is extremely toxic towards locusts and in fact more than anything tried upto this time. It is hundred times more powerful than sodium arsenite which uptil now was considered most effective against hoppers. It is, therefore, hoped that in gammexane a new and highly effective insecticide has been discovered for fighting this scourage known for centuries.

As an agricultural insecticide gammexane possesses the common defect, in that it is also toxic to bees and other useful insects bringing about pollination. Care must therefore be exercised in applying it to fruit producing plants, creepers etc.

Upto this time no toxicity to warm blooded animals has been found by the administration of gammexane along with food. Rats fed for five weeks with ten, twenty or even thirty milligrammes of gammexane had no effect. Crude benzene hexachloride to the extent of hundred grammes given daily with food for a period of two months produced no toxic effect.

Gammexane is also of considerable importance as a soil insecticide. It is of all round effectiveness against many pests of domestic animals such as piglice, poultry red mite, dog-flea etc. Against adult house fly a solution of gammexane in paraffin liquid has been found very effective. It is, however, lacking in the "Knock down" or immediate paralytic action, so characteristic of pyrethrin for use against flying insects. Therefore, gammexane can be used advantageously in conjunction with pyrethrin against flying insects. Gammexane in this case can be looked to a certain extent as complementary to pyrethrin, each supplementing properties which the other lacks.

Gammexane is a powerful larvicide. Its preparations have given higher kills of the larvae of the Yellow Fever mosquitoes than any other material so far tried. Against anepheline and culicine larvae the compound has been found effective under a very wide range of conditions. It has been estimated by some workers that at the most 1 oz. of gammexane (or 10 oz. of benzene hexachloride) per acre will give very satisfactory field control. With as low a concentration as one part of gammexane per million part of wheat, when applied as dust, the compound has been found to be a powerful grain preservative with decided toxic effect to the grain weevil. At the same time no ill effect can be detected in flour made out of the wheat so treated.

As an insecticide gammexane has also the merit of acting as a stomach poison, a contact agent or as a fumigant.

J. B. Lal and B. Biswas.

SEA WEED RAYON

PROF. J. B. Speakman, of the textile laboratory of the Leeds University gives an interesting account of the processes involved, with the sea weed as a source, for the manufacture of rayon. It is believed that sea weed rayons will find an important place in our future textile industry (*Nature*, June 2, 1945).

Dry sea weeds contain 15-40 per cent. of alginic acid, which is readily extracted with sodium carbonate solution and in the early years of the present war, when it became essential to make the fullest possible use in Britain of home-produced raw materials, that the possibility of making rayon from sea weed was investigated. The production of alkali-resistant alginate yarn and the general problems in spinning satisfactory yarn from sodium alginate—satisfactory in appearance, feel and strength—were the problems first investigated.

Yarn of excellent handle and appearance is obtained by extruding a 7·5 8·0 per cent. solution of sodium alginate into a coagulating bath containing calcium chloride (1·0 N), hydrochloric acid (0·02 N) and 2·5 per cent by volume of olive oil emulsified with a neutral detergent such as 'Lissapol C'. With adequate refinements, yarns with a relatively high tenacity, varying from 1·8—2·1 gm/denier at 64·8 per cent relative humidity is produced.

Alkali resistant rayons can be obtained by Cross-linking alginic acid yarn with formaldehyde and with metals of high co-ordinating power such as beryllium and chromium. Still better yarns are produced by treating alginic acid yarn derived from calcium alginate yarn, with the basic acetates of metals. Well washed calcium alginate varn can be stored for periods up to at least 30 weeks without significant loss of strength.

Calcium alginate rayon is the basis of all the alkali-resistant sea weed rayons, which is cheap and easily spun, and possesses satisfactory elastic properties for weaving and knitting. The presence of high metal content (about 10·4 per cent.) has the advantage of making the material totally non-inflammable. The increasing metal content further increases the water-absorption capacity of the rayon that have a marked affinity for basic dyes.

AGAR-AGAR AND ITS SUPPLY

AGAR-AGAR, the most important bacteriological medium is obtained from sea weeds and up to 1939, its production was exclusively a Japanese monopoly. Since the outbreak of the war, the Allies were confronted with the problem of obtaining this vital commodity in adequate amount. Prof. Lily Newton (Née Batten) Professor of Botany of the University College of North Wales, Aberystwyth, gives an account of the world survey of the agar-agar position and also the botanical work carried out under her direction in Britain, where satisfactory agar has now been produced. (*Endeavour*, April, 1945).

The agar-producing weed belong to the *Rhodophyceae*, and harvesting of the weeds has to be organized with due regard to their reproduction and growth periods.

In 1936, 12,000 tons of the weed were harvested in Japan, yielding 2,549 tons of agar, with a value of over 9½ million yen. In the same year the value of the export was 5½ million yen.

First grade Japanese agar was made principally from *Gelidium corneum* Lam and *Acanthopeltis japonica* okan. Other algae used included *Geliduim subcostatum* okan, *Geliduim japonicun* (Harv) okam, *Geliduim pacificum* okam, *Campylaephora hypnoides* J. Ag., *Gracilaria conferroide* Grev, and *Pterocladia capillacea* Porn et Thur.

Frau Fammie E. Hesse in 1881, introduced agar as an invaluable medium in bacteriology and agar agar is the Malayan word for a red alga *Gracilaria Lichenoides* Harv. The physical properties of agar, including its colloidal state, have led to its extensive use in medicine and pharmacy.

In America, a small agar-agar industry has grown up since 1919 and since 1930, New Zealand, South Africa, and Russia, are endeavouring to produce agar.

Britain, with the object of increasing the supply, organized a coastal survey to locate the necessary sea weed beds by Botany Department of the University College of Wales, Aberystwyth, in co-operation with a number of algologists in different parts of the country.

Cytological and cultural research work and studies on the life history of the agar producing red algae is still in progress in Britain. In addition, the autecology of the plants is being studied. It has been found that *Gigartina Stellata* or a mixture of that algae with *Chondrus crispus* after suitable treatment produced an agar, the setting and hardness of which are highly satisfactory for bacteriological work.

The problem of labour has always been acute and the harvesting of sea weeds requires hale, hardy, and thoroughly industrious men who knew the sea. Very numerous voluntary workers have assisted in the harvest in Britain. The weeds are relatively small plants and the task of harvesting needs laborious hand picking. Judicious harvesting is pos-

sible, only if the detailed autecology of the plants is fully understood and this involves laborious field work under rigorous climatic conditions.

Gracilaria lichenoides, the Malayan red alga, grows abundantly in the Chilka Lake in Orissa. The prospects of manufacturing agar agar in orissa has recently been dealt with by Dr H. B. Mohanty in his memorandum on "An Industrial Survey of Orissa, 1945". It is understood that from the few tons of the weed supplied as sample to the medical division of the supply directorate, several million doses of the cholera vaccine has been prepared, and the chilka weed has been found to be richer in agar than the other samples examined by them. But in order to ensure a constant supply of the weed for a long time to come a thorough study of the life history of the weed and on the lines as indicated by Prof. Newton ought to be undertaken.

The establishment of such an industry in India should receive every encouragement from Central and Provincial Governments as the manufacture of agar will provide a great incentive to manufacture vaccines and biological products. For this investigation the services of botanists will be as important as that of the chemists.

INSECT BORERS OF BAMBOO AND THEIR CONTROL

BAMBOO is one of the most useful forest product of India and cosmopolitan in its distribution. But it is the most neglected plant of India from the point of view of cultivation, preservation and improvement of species.

Owing to enormous war demands for bamboo, the question of preventing insect attack became of great importance and was taken up as a special problem in the Entomology branch of the Indian Forest Research Institute, Dehradun.

By far the most important borers in felled bamboos belong to the closely allied families Bostrichidae and Lyctidae caused by species of *Dinoderus* (*minutes, brevis, ocellaris*). Of the species that bore in living culms, *Estigmena chinensis*, a chrysomelid beetle, the larva of which tunnels in the wall of the internode is important. It is very common to see such badly attacked culms often being used for scaffolding and ladders (*Indian Forest Bulletin*, No. 125, 1945).

Culms are often attacked within 24 hours of felling and in Dehradun, there are two generations in a year between March and September and a third during the cold weather. The external appearance of culm may not indicate the degree of the internal damage.

The presence or absence of starch is a valuable indication of the liability of bamboo to attack by insects as for both Lyctidae and Bostrichidae starch food is essential.

Water immersion for three months prevents Bostrichid attack ; the starch content in the immersed culms is not apparently altered, only the soluble sugars being removed.

Methods of impregnation with creosote, after longitudinal drilling of culms by soaking, open tank and pressure processes are briefly discussed in this bulletin.

Loss of bamboo, due to fungal attacks has so far received very little attention by the mycologists in India. Bannerjee and Ghosh (*Science and Culture*, VIII, p. 194) listed 31 species of higher fungi in Calcutta, growing either on the living or dead bamboos and causing heavy loss of the bamboo population. Nothing is known as yet, about the protection of bamboos from fungal attack.

PHOTOELASTICITY

S. K. GHASWALA,

PUBLIC WORKS DEPARTMENT, BOMBAY

TO the many advances that have been made in recent times in the field of applied science, the growth and development of photoelasticity mark a new chapter in engineering and herald a new era in the domain of stress analysis. As its name indicates, photoelasticity is a method of determining the elastic nature of a structure by means of photography, the actual process of stress evaluation being carried out on suitable models of the prototype by means of experimental optical methods.[1-6]

It was as far back as 1816 that Brewster[7] observed that a piece of glass under a compressive stress acted like a doubly refracting prism, a single wave of light being resolved into two distinct waves having their planes of vibration along the directions of principal stresses. An exact relation between stress and relative retardation was, however, not established until 1854 by Wertheim. Successive investigations on the subject were then carried out by Wilson, Neumann, Maxwell, Mach, Kerr, Pockels,

and others[4], and although their work resulted in the formulation of stress-optic and strain-optic relations, the exact application of this science in general engineering problems remained in the dark till the close of the last century.

The detailed and exact analysis of the optical methods investigated so far were further taken up by Dr E. G. Coker, F.R.S., and Dr L. N. G. Filon, Vice-President of the Royal Society, and Vice-Chancellor of London University, who, at the time of his death in 1938, occupied the Goldsmid Chair of Applied Mechanics and Mathematics at London University. These distinguished men of science, by their persistent and life long efforts, laid as it were the real foundation of the science of photoelasticity as is known today and in 1930 pioneered in the publication of their classic work, "The Treatise on Photoelasticity." This opus magnum presents a corner stone in the development of the science of stress analysis and remains not only as a monument to their accomplishments, but also as a treasure of inspiring suggestions to their followers. Since this publication, a number of other similar books have been brought out in different countries like France, Germany and America[2, 3, 5, 6]. The photoelastic laboratory first set up by Dr Filon at London University where students came from all over for research work has served as an incentive for the establishment of other similar laboratories, with the result that today there are a number of educational and other large industrial institutions especially in America, such as California and Cornell Universities, and Bureau of Reclamation, Denever, Colorado, where photoelastic work is being energetically carried out. Because of this, the work of its pioneer Dr Filon is now regarded as international in character.

Foremost among the methods of stress analysis is the mathematical theory of elasticity, which furnishes stress functions from which the most exact stresses and strains can be calculated. However, with the development of complicated structures having irregular boundaries and loading the mathematical difficulties conspicuously increase. The analytical solutions of partial differential equations with complex boundary conditions thus become unwieldy for practical purposes and the general utility of the theory is lost. Experimental methods have, therefore, to be resorted to, and it is herein that photoelasticity plays its part.

The usual phenomenon of double refraction observed in crystalline bodies such as tourmaline, mica and calcite is a permanent optical property of the materials. This phenomenon, however, can also occur in isotropic pieces of glass, celluloid and bakelite, which become doubly refracting under normal stresses or strains, the condition of double refraction disappearing when these strains are removed. It is this property that is made use of in photoelasticity. The principal stresses and strains produce physical deformations which completely change the isotropic character of the material, with the result that when it is loaded and differentially deformed a ray of light entering it will travel faster along one principal plane than along the other, *i.e.*, it will have different wave lengths along different planes. Thus if a piece of celluloid or xynolite is put under stresss and a beam of polarized light sent through it, the beam will split up into vibrations along the planes of principal stresses. If now the emergent beam is passed through a nicol prism (called the analyzer), a rainbow coloured image will be formed on the far side of the analyzer due to light interferences caused by the relative retardation of the two light components. Hence the colour effects form a measure of the difference in magnitude of the two principal stresses. Besides these colours, dark lines, known as fringes, will also appear, representing the loci of points of constant difference between the two principal stresses. The locus of points along which these principal stresses have parallel directions is called an isoclinic, from a group of which a complete picture of stresses can be obtained. This is of course the most elementary principle underlying the theory of photoelasticity. Many intricacies exist in actually employing the method in the laboratory, such as the determination of fringes and fringe order, and evaluation of stress trajectories and other functions. If a model of celluloid or any other photoelastic material is, therefore, prepared and loaded in a manner similar to its prototype any point in that model produces a definite number of optical cycles as the loading on it is increased from zero to a maximum. Experimentally it is observed that within the limit of proportionality (elastic limit), the retardation in wave lengths produced by a given load system by temporary double refraction is directly proportional to the applied loads. According to this law the relative retardation (or phase difference) in wave lengths in isotropic plates subjected to two dimensional stresses is given by the product of the plate thickness, the difference in principal stresses, and a constant (depending on the physical properties of the photoelastic material) termed the stress optic coefficient. Beyond the elastic limit, *i.e.*, in the plastic range or when strain creep occurs, the laws become complicated and are still imperfectly understood.

Regarding the problem of photoelastic materials, an hypothetically ideal one would be one having moderate cost, constancy of properties during changes in temperature and treatment, high modulus of elasticity, freedom from initial stresses, absence of undue mechanical or optical creep, proper hardness, good machinability, and above all high optical sensitivity and transparency. Among the common materials

satisfying these properties are those belonging to the class of natural and synthetic polymers, natural resins and glass. In fact, glass is the oldest photoelastic material having been used by Mesnager for studying stresses in a model of a bridge over the Balme as far back as 1913. Although it satisfies many essential requirements, its main disadvantages are its low optical sensitivity and poor machining qualities, as a result of which it is not much used at present, except for determining stresses in solid blocks simulating stone masonry or brick arches. Next to glass, celluloid[8] and bakelite are two of the commonest photoelastic materials. The introduction of celluloid, first evolved by John Wesley Hyatt about 75 years ago and brought into the realm of photoelasticity by Dr Coker in 1906, gave a considerable impetus to this optic science, resulting in the formulation of a vast number of researches ; and although today celluloid is being slowly replaced by bakelite, this natural polymer must still be regarded as a basic material for carrying out photoelastic work on large and complicated models. The form of commercial celluloid known as xynolite which contains about 24 per cent camphor has been found most suitable for general work. Of all the photoelastic materials probably none approaches the ideal requirements as bakelite, a glycerin phthallic anhydride which was first introduced in the early twenties and is five times as sensitive as celluloid. The form most exclusively used in America is bakelite BT-61-893. The use of phenolite[9], a material closely akin to bakelite, is favoured in Japan, trolon is used in Germany while L'Orea and Rhodoid are employed in France. Among the most recently employed materials, gelatine[10] is the most sensitive substance yet known as far as double refraction is concerned. As its optical sensitivity is nearly 600 times that of bakelite, it is well suited for the study of stresses due to body forces, as well as in soil mechanics problems like stress distribution in foundation carrying triangular load simulating earth dams, in earth embankments due to their own loads and in stresses about tunnels. Extensive use of gelatin in earthen dams has been made in the Soil Mechanics Laboratories of U. S. Engineer's Office, Pittsburg, Pa, and in the U. S. Laboratories at Fort Peck for evaluating foundation stresses in Fort Peck Dam.

Photoelastic methods as adopted today are generally two-dimensional, though some of the modern researches have shown that certain materials like bakelite and trolon are capable of exactly duplicating stresses when used for three-dimensional model experiments. If these materials are heated, then loaded and stressed and then cooled under load, the resulting deformation produces stress fringes which remain in the material and are termed "frozen stresses". When completely cold, the models can be actually cut open and sliced along the three perpendicular planes representing the 3 axes along which the stresses can be examined. The exact interpretation of the stresses along the axis is obtained later by solving a set of non-linear 2nd degree equations from a consideration of Fresnel's ellipsoid. Frozen stress patterns were first published by A. G. Solakin in 1935[11], while a year later G. Oppel[12] was the first to state that the process of slicing or cutting does not disturb the frozen pattern. The fundamental laws governing these patterns were, however, ultimately investigated by M. Hetenyi[13] in 1939 after whom this method received a new impetus. The general principles underlying these phenomena are explained in the light of the diphase molecular theo [5]. According to it, a hardened resin used in any photoelastic work is composed of two parts, an infusible 3-dimensional skeleton embedded in a fusible matrix. The former constitutes only a small part of the total volume and is formed from the fusible part by polymerization. At room temperature, the fusible part has a high viscosity co-efficient and carries most of the load applied to the model, with almost negligible creep, but at high temperature the viscosity coefficient decreases so that the fusible part flows and gradually transfers the load to the infusible skeleton. The deformation under constant load, therefore, approaches a limiting value which is determined by the percentage of polymerized material and its elastic properties. Since the equilibrium between the fusible and infusible parts exists over regions of molecular proportions, the state of stress corresponding to the deformation is essentially undisturbed by the slicing of the model. This, in brief, is the usual picture which modern chemists hold regarding the diphase molecular structure of bakelite.

Applications of the Method

The applications of this method are not restricted to any particular branch of engineering, but spread their tentacles in many varied spheres. Thus photoelasticity finds use in the investigation of elastic properties of many materials like cellulose derivatives, in the study of stresses in gear teeth, beams, brackets, hollow cylinders, fillets of shafts and screw threads, as well as in designing members for fatigue strength. In fact, photoelastically determined stress concentration factors have been found to apply directly in determining the fatigue strength of silicon and hardened steels. Apart from its role in evaluating principle stresses, photoelasticity can accurately yield stresses on free boundaries and can simplify the solution of statically indeterminate frameworks. The phenomena of frozen stress patterns described above forms one of the most important applications in modern 3-dimensional photoelasticity, such as in the study of dynamic stresses due to rotation[16] and of bolt and nut

fastenings and other threaded connections having axial symmetry[21]. In large structures like dams and bridges where load distribution varies with the actual deformation, models of two different photoelastic materials are made and their joint behaviour studied, by keeping the modulii of elasticity of the two materials the same as the ratio of the materials comprising the original structures. A recent development attempted at present in the Civil Engineering Department of the University of California for the determination of dead load stresses in large masses is to "freeze" in a model the stresses obtained by centrifugal force using a centrifuge in a temperature controlled oven and to analyze the result later in an ordinary polariscope. By further research it may also be possible to superimpose additional loads at room temperature on a model with gravity stresses already present and obtain the final stress pattern. Among the other problems investigated at present but which are as yet in their nuclear stage of development are structures subjected to high gravity stresses in which liquid gelatin models have been tried, structures like large Pyrex insulators on transformers which are known to fail under a combination of casting stresses and stresses due to an electrical field, wherein bakelite models would yield promising results[17], and reinforced concrete structures wherein models of bakelite are cast with aluminium rods and studied photoelastically[18]. Instead of using ordinary photographs a motion picture study holds out good possibilities for demonstrating the manner of fringe formation. Recently Tuzi in Japan has utilized a high speed camera to record impact stresses in a phenolite beam. A neon light source was used to give the necessary sharp extinction and photographs were taken on sensitive panchromatic film.

Regarding thermal stresses[17] (which are elastic stresses produced by non-uniform thermal expansion of a member) and quenching stresses (which unlike the former are trapped or residual stresses resulting from plastic flow of the material), no research as yet on an extensive scale appears to have been carried out, the only information available being the photoelastic study carried out by Biot[19] for calculating thermal stresses in hollow cylinders by the use of a Beggs' "deformeter". Another branch of development which suggests itself for future investigation is the combined use of optically sensitive and insensitive materials for studying stresses in special cases such as overlapping parallel plates joined by rivets, and for the plotting of isoclinics. Materials like Lucite (made by Du Pont) and Plexiglas (made by Rohm and Haas) satisfy these requirements and represent probably another class of typical future photoelastic materials. The influence of a material on its stress distribution appears to be inseparably connected with certain phases of the theories of elasticity and plasticity, there existing a very great possibility that the final results of this stress distribution obtained from photoelastic analysis could be directly applicable to structural materials. Photoelasticity apart from its predominating role in engineering provides the physicist with a new and additional method of exploring the interaction of molecules and atoms with radiation whence it may elucidate the condition of matter in the solid state and open out vast unexplored domains whose potentialities may be impossible to fathom out at present.[20]

Ordinarily the photoelastic method directly determines the difference between the principal stresses with simplicity, and high accuracy. Sometimes, however, it becomes necessary to find not only the direction of principal stresses but their actual values also at points where they are not given directly by the fringe pattern, such as in the problems of contact stresses and curved beams. The determination of these values was formerly considered to be the most complex part of photoelastic technique and one usually never attempted. Today, however, as a result of a number of systematic researches, several methods have been evolved for fully obtaining the solution of principal stresses. Among these the commonest are the theory of Oblique Incidence suggested by Drucker and Mindlin[22], Weller's method of using scattered light[23], Filon's graphical integration method[1], and other general refinements on these by Hiltscher[24], Kuske[15] and Frocht[2]. The application of brittlelacquer coatings to photoelastic models described by the writer in this journal some time back[25] also presents a relatively quick and direct method of obtaining the stress trajectories which can be recorded photographically over the whole field at once.

The scope of 3 dimensional photoelasticity is at present limited by the quality and size of the materials available for model tests, as well as by the difficulty of making the boundary and boundary stresses visible especially at stress concentrations. With the development in photoelastic materials which would permit the moulding or casting of complicated shapes and which would also be free from time stresses, the power of the photoelastician will sharply mount.

If in the present stage of development, the engineers designing an R. C. C. or steel dam tarried for mathematical elasticians to supply them with a reliable stress analysis the dam would not be built. In fact, to-day a few models and a photoelastic laboratory do easily in a few months what no mathematician could accomplish within a life time. Nevertheless, it must be clearly known that this triumph of modern efficiency owes a deep and a very significant debt of gratitude to the theoretical labours of internationally renowned French mathematicians like Navier, Poisson and Cauchy, who developed elasticity and the closely allied analysis of wave motion from a mathematical

basis. Cauchy, in particular, by his elaboration of the elastic-solid theory of light in about 1840, contributed to the physics from which the present photoelastic technique evolved ; and although this elastic-solid theory collapsed long since like the luminiferous ether it once supported, it has left a substantial residue in widely used mathematical methods which are applicable to various branches in the field of applied science, of which photoelasticity forms one of the most predominant aspects. Because of its close relation with physics and mathematics, it becomes evident that with advances in these branches of science, photoelasticity can also develop substantially as is well exemplified in America. That country, through her photoelastic laboratories, Eastern Photoelasticity Conferences, and now through the newly created Society of Experimental Stress Analysis, leads other nations in the progress and development of this optic science. In fact, in the words of Professor Max M. Frocht of The Carnegie Institute of Technology, " . . . photoelasticity has grown to the full stature of a powerful technical instrument of quantitative stress analysis which for two dimensions at least exceeds all other methods in reliability, scope and practicability. There is no method by which the complete exploration of principal stresses, let alone the stresses on free boundaries, can be determined with the same speed and accuracy and at such a surprisingly small cost as the photoelastic method."

Regarding India's contribution to this branch of applied science, it is rather unfortunate to note that practically no effort has so far been made to establish it on a firm basis, for the writer is yet unaware of the existence of any well equipped photoelastic laboratory comparable with those found in any European or American Universities or other technical institutions. Probably the only work that appears to have been carried out in this country is by the Government of India, Railway Department[26] in analyzing the distribution of primary and secondary stresses in rail sections by means of 2-dimensional xynolite models. In view of the growing importance of India's industrialization it is confidently hoped that the need for the establishment of efficient photoelastic laboratories in various engineering colleges as well as in the newly proposed institute of higher technology on the lines of the Massachusetts Institute of Technology will be fully realized, for it is only by the adoption of such modern methods of analysis that India can hope to maintain engineering and technological progress and be able to stand in the front rank of other nations of the world.

Bibliography

[1] "Treatise on Photoelasticity" by E. G. Coker and L. N. G. Filon, 1930.

[2] "Photoelasticity" by M. M. Frocht, Vol. I, 1941.

[3] "Élasticité et Photoélasticimétrie" by H. Le Baiteux and R. Boussard, 1940.

[4] "A Manual of Photoelasticity for Engineers" by L. N. G. Filon, 1936.

[5] "Optical Methods of Stress Analysis", Publication of Applied Mathematics & Mechanics of Bulnoff University, Leningrad, U.S.S.R., 1931.

[6] "Spannungsoptik" by G. Mesmer, 1940.

[7] D. Brewster, *Phil. Trans. Roy. Soc.*, 1816.

Edmonds & McMinn, "Celluloid as a medium for Photoelastic Investigations", *Trans. A. S. M. E.*, 1932, A.P.M. 54-8, p. 77.

[8] M. Nisida, "Physical Properties of Phenolite", *Sci. Papers Inst. Phys. & Chem. Res.*, Tokyo, Jan 1933.

[9] F. B. Farquharson & R. G. Hennes, "Gelatin Models for Photoelastic Analysis of Stress in Earth Masses", *Civil Engineering*, V. 10, No. 4, April 1940.

[10] A. G. Solakin, "A new Photoelastic Material", *Mech. Engineering, 57*, 767, 1935.

[11] G. Oppel, "Polarisationsoptische Untersuchung räumlicher Spannungsund Dehnungszustände", *Forschung auf dem Gebiete des Ingenieurwesens, 7*, 240, 1936.

[12] "Photoelastic Studies of 3-Dimensional Stress Problems", *Proc. 5th Int. Congress for Appl. Mechs.*, 208-212, 1939.

[13] M. Hetenyi, "The Fundamentals of 3-Dimensional Photoelasticity", *Jnl. of Appl. Mechs., 5*, 149-155, 1938.

[14] A. Kuske, "Das Kunstharz Phenolformaldehyd in der Spannungsoptik", *Fors. auf dem. Gebiete des Ingen, 9*, 139, 1938.

[15] M. Nisida, "Photoelastic Investigation on Rotating Bodies", *Sci. Papers Inst. Phys. Chem. Research*, Tokyo, *16*, 719-736, 1937.

[16] S. K. Ghaswala, "Photoelastic Methods of Analysis", Suppl. Rept. 5th Ann. Meeting Assoc. Eng. Grad. U'sity of Bombay, p. 7, 1944.

[17] Bayer & Solakin, "Photoelastic Analysis of Stresses in Composite Materials", *Transactions A. S. C. E., 99*, 1196, 1934.

[18] M. A. Biot, "Gravity and Temperature Loading Replaced by Boundary Pressures and Dislocations", *Jnl. Appl. Mechs.*, 1935.

[20] *Engineering*, 14 Jan. p. 34, 1938.

[21] M. Hetenyi, "A Photoelastic Study of Bolt and Nut Fastenings", *Trans. A. S. C. E.*, J.A.M., Vol. 65, p. A-93.

[22] D. C. Drucker, "Photoelastic separation of Principal Stresses by Oblique Incidence", *Jnl. Appl. Mech.*, Sept. 1943.

[23] R. Weller, "Three-Dimensional Photoelastic Analysis by Scattered Light", *Proc. 9th Eastern Photoelasticity Conf., Cornell U'sity, 1939.*

[24] R. Hiltscher, "Polarisationsoptische Untersuchung des räumlichen Spannungszustandes in konvergenten Licht", *Fors. auf. dem Gebiete des Ingen, 9*, 91-103, 1938.

[25] "Use of Lacquer in Strain Analysis", SCIENCE AND CULTURE, *9*, 76, 1943.

[26] W. E. Gelson & E. A. Blackwood, Track Stress Research Progress Report", Vols. 1 & 2, Nov. 1935-1938.

MEDICINE AND PUBLIC HEALTH

EYE BANK

ACCORDING to a report of the *Science News Letter*, April 21, 1945, an eye bank styled as the Eye Bank for Sight Restoration was established last year to 'make available a supply of fresh or preserved corneal tissues wherever and whenever needed by hospitals and surgeons who are qualified to perform the corneal graft operation'. The Eye Bank further proposed to undertake research activities with the object of discovering a new method for longer preservation of corneal tissues taken from a living or dead person. The method of preservation, now available, does not permit of the storage of corneal tissues for more than three days before transplantation.

The Eye Bank will render yeoman's service in assisting in the treatment of preventible blindness following defects of the cornea. That corneal blindness can be successfully dealt with is an old idea. In fact, attempts to relieve such blindness by substituting transparent material for the cornea can be traced to as early a date as 1789. Methods of grafting corneas, developed successfully during recent years, have been highly reassuring. The only handicap in the way of large-scale application of these methods lay, however, in the lack of supply of corneal tissues for which an eye bank was the only solution. It is estimated that some 10 to 15 thousand blind persons may have now a chance to see again, thanks to the efforts of the Eye Bank for Sight Restoration.

It is interesting to note that in 1941, prior to the establishment of the Eye Bank, the Dawn Society was formed under the sponsorship of the International Order of Good Templars. The members of the Society pledged their eyes at death for purposes of corneal grafting to cure blindness.

CINCHONA MISSION IN SOUTH AMERICA

WITH the Japanese invasion of the Dutch East Indies in 1942, the primary source of quinine was suddenly and unexpectedly cut off. Since then a considerable area in South America has been surveyed in search of other wild species containing a minimum alkaloid content. Dr F. R. Fosberg and Mr W. C. Steere, botanists of the University of Michigan, report an interesting account of their explorations in the mountains of South America in *Science*, February 16, 1945. In addition to *cinchona pubescens and cinchona officinalis* (the latter producing bark of high quality), another species *viz.*, *Remijia pedunculata*, was re-discovered in Colombia. The bark of this non-cinchona contained as much as 3 per cent. of quinine sulphate, with very little admixture of other alkaloids.

In the seventies of the last century, many thousands of tons of the bark of this tree were exported to Europe for the extraction of quinine. After several years, the trade in *Remijia* bark waned as a result of the depletion of readily available forests.

Remijia purdieana and *R. pedunculata* were also introduced into India and grown in the Sikkim plantation and Nilgiri hills to furnish raw materials to the quinine industry, and the quinine contained in it was in an easily extractable form.

Cinchona pitayensis was also discovered between altitudes 8,500 and 10,000 ft. in Ecuador, and it had been previously overlooked because of the tradition that the best races of cinchona occur between 3,000 and 5,000 ft.

Many species of Remijia, Landenbergia and other rubiaceous genera closely resemble cinchona to the untrained eye, but the technical aid of both botanists and chemists of this mission has saved many thousands of dollers which dealers would otherwise have invested.

The publication of these highly important researches on cinchona and related genera and the taxonomy of this difficult group of plants and misunderstood genera will be awaited with interest.

FOOD PROBLEM IN BENGAL*

A. C. UKIL,
CALCUTTA

THE area of Bengal is 50·3 million acres or 77,442 square miles, rather more than the area of England, Wales and half of Scotland taken together. Most of the territory is comprised of the deltaic plain facing in the south the Bay of Bengal and is richly supplied with rivers, except in the central and western parts. The population is a little over 60 millions, which is well in excess of that of the United Kingdom and not much less than the aggregate population of France, Belgium, Holland and Denmark.

Out of 30 million acres of cropped area, a little less than 26 million acres are devoted to cultivation of rice. Of the remainder, 2-2½ million acres are devoted to jute ; only 250,000 acres to wheat ; and the balance is left for the cultivation of vegetables, fruits and non-jute cash crops. Bengal accounts for 20 per cent of the all-India production of rice. Only 7 per cent of the cropped area is irrigated and only 6 million acres are double cropped. 12 million acres of land are lying waste as current fallow and culturable waste. 14 per cent of the total area of the Province is under forests. Bengal has a vast water surface which is lying untapped so far as fish supply is concerned.

It has been shown that agriculture cannot support more than 250 persons to the square mile, and Bengal has an average density of 650 persons to the square mile, there being more than 1,200 persons to the square mile in some parts of Eastern Bengal. There is thus not only a shortage of cultivated and cultivable land but actual production falls far short of the requirements of the increasing population.

According to the recent Famine Enquiry Commission, the number of families in Bengal wholly or mainly dependent upon cultivation of land for their livelihood is approximately 7·5 millions. Less than 2 million families hold more than 5 acres each ; about a third of this number hold more than 10 acres each ; about 2 million families hold between 2-5 acres each and the others constituting approximately one-half of all the families, depending wholly or mainly on the cultivation of land, either hold less than 2 acres each or are landless. The cultivating families include roughly about 1 million families living mainly or entirely as *bargadars*, that is, crop sharing tenants. The number of families living mainly or entirely on agricultural wages is approximately 2 millions, landless labourers number about 30 lakhs, while non-working dependents number 4 millions.

A cultivator needs not only food crops (cereals and pulses, vegetables and fruits) and fodder for cattle, but also commercial or cash crops, like oil-seeds, jute, tea, fibres, sugar, tobacco etc., to enable him to purchase his other requirements.

A properly constituted diet should not only contain *energy-yielding foods* like cereals (rice, wheat, barley, *jowar-bajra* oats, Indian corn, etc.), fats and sugar, but also *protective foods* or foods which protect the body against dysfunction and disease, such as proteins (animal proteins—milk and milk products, fish, eggs and meat ; vegetable proteins—pulses, peas, beans, lentils and nuts), mineral salts and vitamins which are available from green leafy vegetables, root vegetables and fruits. Infants and growing children need relatively more animal food, particularly milk and milk products and vitamins than adults. Expectant and nursing mothers need more of the protective foods, while the sick population have their special requirements. From this, it will appear that food is not to be looked upon as merely consisting of rice, potatoes, fish, meat, eggs, vegetables and fruits, but of certain well recognised chemical entities, such as carbohydrates, proteins, fats, minerals and vitamins. If the proper proportion of these constituents is not assured in the daily diet, a failure of growth and health takes place. It is now recognised that a large proportion of sickness in the community can be reduced by a proper adjustment of the diet and healthful living. The supply of a proper and adequate quantity of food to the different age and sex groups of the population is, therefore, of fundamental importance to national health in any country.

The dietetic requirements at various ages are shown in the tables given in the Appendices, from which it will be seen that they cannot be secured at less than Rs. 10 12'- per capita per month at pre-war rates.

An average adult belonging to Bengal requires for his daily diet : 12 ounces of rice, 4 ounces of other cereals ; 2 ounces of pulses, 4 ounces of milk, 2 ounces fish or meat (if fish and meat are not available, add another 4 ounces of milk in their place), 6 ounces of non-leafy vegetables, 4 ounces of green-leafy vegetables, 2 ounces of fats and oils, and 2 ounces of fruits. The food problem in Bengal has to be judged in this context and for the needs of the different age and sex groups of the population.

* Opening remarks on "Food Problem in Bengal" at a meeting of the Royal Asiatic Society of Bengal held on July 2, 1945.

There is an average of 5 persons per house or unit of family in Bengal and there are 2-5 non-working dependents to every earner and worker. Each family has only 3·34 acres of cultivable land, as against 21 acres in England. Moreover, very few of the cultivators in Bengal own the land themselves. Elsewhere we have shown that the Bengal peasant needs to possess and improve the land where he grows his food and that he needs to increase his income at least eight to ten times, if he is to lead a healthy life according to minimum hygienic standards.*

Consideration of the Main Deficiencies in Food Production

Rice.—Deducting 550,000 tons for seed requirements, the shortage of food with regard to rice is estimated to be 2 million tons. Until the occupation of lower Burma by Japan, one and a half million tons of rice used to be imported annually into Bengal. It has been shown that if rice is hand-pounded and fine milling is avoided and rice water is not rejected in cooking, the amount of rice that is needed for nutrition can be reduced by 20 per cent. It has further been shown in Phillipines that if 20 per cent of soya bean is cooked with rice and a few vegetables are added to it, it not only helps in reducing the amount of rice consumed, but produces a much better balanced diet.

It will be interesting to note that the yield of rice per acre in India is 823 lbs., in comparison with 4,743 lbs. in Italy, 3,179 lbs. in Egypt, 2,988 lbs. in Japan and 5,542 lbs. in Spain. While many parts of Bengal are suitable for the cultivation of sugar cane, she has to import annually Rs. 3 crores worth of sugar from U. P., Bihar and other provinces.

Wheat.—On an average 300,000 tons of wheat are consumed every year in Bengal as against a production of only 74,000 tons (this is equal to a shortage of 226,000 tons). As wheat is one of the most nourishing cereals, the population can be gradually encouraged to consume more wheat in preference to rice.

Pulses and Beans.—Approximately 153,000 tons of these vegetable proteins are imported annually into Bengal. A certain amount of maize (equal to 6½ million maunds) is consumed mostly by poorer people residing in the hills. This does not take into consideration the requirements of pulses and oil-cakes for domestic animals.

Groundnuts grow easily in many parts of Bengal, but still she imports Rs. 10 lakhs worth of groundnuts and Rs. 5 lakhs worth of groundnut oil annually from Madras. It is well-known that Soya beans not only provide food containing high-grade protein but also valuable commercial products. Hardly any attempt has been made to encourage the cultivation of soya beans and groundnuts in this Province.

Fats and oils.—Bengal produces only 1/10th of her requirements of mustard oil. Butter is not generally used by the poor peasants of Bengal, but in spite of this Rs. 75 lakhs worth of butter is purchased annually from other provinces, and Rs. 3 lakhs worth of *ghee* (clarified butter) is purchased from other provinces and Indian States. Taking advantage of the present wartime transport difficulties, the manufacturers are adulterating these foodstuffs and there is hardly any agency in the country to detect and control this pernicious practice.

Vegetables.—Vegetables grow easily in almost all parts of Bengal, but still Re. 1 crore worth of potatoes and Rs. 25 lakhs worth of onions are annually imported into the Province from other areas.

Milk and eggs. The amount of milk produced varies greatly in different parts of India. In the Punjab, the estimated per capita production of milk is 19·7 ounces, while in Madras it is 3·6 ounces and in Bengal 3 ounces, as compared to 45 ounces in Australia and 38 ounces in Great Britain. Milk is a very essential constituent of food for infants, growing children, expectant and lactating mothers. Instead of trying to produce more milk, Bengal imports Rs. 60 lakhs worth of milk products annually from foreign countries. It is estimated that the number of animals per acre of grazing land in Bengal is 30 to 69, while the proper number should not exceed 2 or at the most 3. Food shortage and inferior breeds account for the poor milk yield in this part of India. It is known that milch cows yielding less than 2 seers of milk per diem are considered to be uneconomical to maintain. Thus ill-nourished cattle instead of supporting the peasant are proving a drag on him.

Bengal imports annually Rs. 2½ crores worth of eggs to feed her population, in spite of the fact that she can be made self-sufficient with regard to poultry and poultry products.

Fruits.—While Bengal soil has a reputation for fruit production, she imports annually, besides fresh fruits, Rs. 20 lakhs worth of dried fruits, and Rs. 5 lakhs worth of jam and jelly from foreign countries.

The export of food products (produced in Bengal) from Bengal is insignificant compared to the amount of food imported into the province.

From the above it will be seen that there is a shortage of almost all articles of diet which the people consume in this Province, but the most serious shortage is with regard to the protein or nitrogenous

*An estimation of these standards will be published in a subsequent issue of this journal.

foods and vitamins, which are so necessary to build up the physique and resistances to infection of the population. It is no wonder that the stamina of the Bengalee is the lowest in India. Every moment of our lives nitrogen is being excreted, chiefly through the urine, and it needs to be replaced. The nitrogen depletion of the soil, without being replaced, has been an important cause of deterioration of the cultivated soil in Bengal.

Causes of Agricultural Deterioration

The causes of agricultural deterioration in Bengal have been said to be due to the absence of adequate irrigation facilities, silting up of rivers and irrigation tanks, deterioration of bunds and tanks, defective drainage of *beel* areas and water hyacinth, floods and denudation of forests, and finally fragmentation of holdings and non-possession of the land by tenants.

While the population continued to increase, there was hardly any corresponding increase in the area under food crops. The productive capacity of the soil decreased so much that within the decade 1931-1940, the production of rice per acre fell by nearly 100 pounds. The almost complete conversion of pastures into tilled lands and uncontrolled breeding of cattle, along with the increasing poverty of the people, led to deterioration of the cattle population, and a regular scramble for food has ensued between man and cattle. The almost complete lack of policy in crop planning, in terms of the nutritional requirements of the different age and sex groups of the population, and of technical background in the administration have brought the population to a state where poverty, disease and death are flourishing. Apart from warnings given by different workers from time to time, the strong group of scientific workers in Bengal studied the problem and issued timely warning to the Bengal Government immediately on the outbreak of war in 1939. The advice given by these scientific workers went unheeded and the situation still remains desperate. It is widely recognised that health is a purchaseable commodity and that adequate nutrition is the first requirement of healthful living. The approximate direct expense on agriculture per head of the population is less than Re. 1/- in India, as compared with Rs. 12 to Rs. 14 in the U. S. A. and U. S. S. R. Besides, an overall per capita income of Rs. 5/- per month cannot give the same health to the people of our country as is enjoyed by the people of the latter countries. The so-called "Grow More Food Campaign" during the war has been devoted, according to my impression, more to publicity and propaganda than to any scientifically planned drive for food production. A fair amount of researches has been done in India but few of them have been put into practice. Unless the administrative authorities listen to technical advice, our country is likely to remain very much in the same position after this war as before. Moreover, it is no good producing food unless the prices are within the economic competence of the poorer groups of the population.

Food Planning

The objective of any food policy should be to supply (*a*) a sufficient quantity of protective foods, and (*b*) a sufficient quantity of energy-producing foods for the *different age and sex groups of the population* in an area, according to the nature of their work. The planning of crops should take note of the requirements of commercial or cash crops, without detriment to the food requirements of man and cattle. Agriculture and animal husbandry must progress hand in hand.

A judicious crop planning implies the introduction of improved and resistant varieties of seeds and of improved methods of cultivation with the aid of more efficient implements and proper manuring ; the application of a suitable cropping scheme by a judicious distribution of grain, fodder and money crops and a soil recuperating crop on the available soil ; a better control of pests and diseases to avoid the loss in yield caused by them ; demonstration and education of farmers with regard to the equitable allocation of food and commercial crops and to horticulture and backyard farming ; the encouraging of a larger cultivation of those crops which are likely to make up for the deficiencies in the national diet, *e.g.*, pulses, soya beans, gingely, groundnuts, wheat, etc., if necessary, by offering concessions to the *ryot* in the form of remission of revenue assessment ; and finally the introduction of suitable marketing and distributing machinery by means of cooperative seed stores, storage and selling organisations. Unless the principles of rationing are borne in mind as regards the equitable distribution of foodstuffs to all groups of the population in the post-war period, the general nutritional level of the population will lag behind as it happened with 40 per cent of the population in Britain and 45 per cent of the population in the United States before the war.

It is the duty of the State to initiate and organise these improvements. Control and harnessing of rivers, the prevention of erosion, and pursuing a steadfast policy of drainage and irrigation are vital factors in land reclamation and utilisation, which should also be a charge on the State. The provision of improved transport facilities should also be a charge on the State. Unless the entire machinery of

the Government, including the Departments of Agriculture, Irrigation, Communications, Veterinary, Cooperative and Industries come forward to help in a coordinated drive, it is futile to expect any results even in the post-war period.

Although opinion regarding the estimates for the proportionate increase of food production is not uniform, it can be safely stated that the production of cereals in Bengal will have to be increased by 30 per cent, pulses by 100 per cent, vegetables, especially green vegetables, by 40 per cent or more, milk and milk products by 500 per cent or more, and meat, fish and eggs by several hundred per cent.

India's population will continue to increase. Nothing can stem the tide so long as education and the standard of living do not advance. The population cannot afford to pay for imported food from other provinces and from foreign countries at an increased cost. Under the circumstances, the only alternative open to us is to apply science to produce more food not only from the soil and the animal kingdom, but also take advantage of technological researches in the manufacture of concentrated and synthetic foods in the laboratory.

(1 *Cereals, pulses and vegetables.*—It will be seen from what has been stated that if we have to increase production from the existing area of land by at least three times, we cannot depend on cattle manure or compost, which has a low nitrogen content alone but that the use of chemical fertilisers is absolutely essential. This must be supplied to the peasant at a nominal cost, at least during the initial stages of the campaign. The increase in yied from the judicious use of inorganic fertilisers more than offsets the additional cost in setting up plans and manufacturing them. It should better be borne by the State. Inspite of our having enormous coal resources within and near the borders of the Province, the importance of the coal processing industry in the manufacture of fertilisers, insecticides, disinfectants, herbicides, fungicides, fumigants, preservatives, plant growth regulators, and food dyes, is not generally realised by our administrative authorities. The results of work undertaken by a small plant in Mysore should open the eyes of all who wish to recondition Indian agriculture. Indian scientists have cried hoarse over it.

The use of compost and synthetic fertilisers will not only help us to make up for the deficit of one and a half million tons of rice, which used to be imported from Burma, but also supply us with 550,000 tons for seed requirements from a reduced acreage, thus releasing land for growing essential crops like wheat (estimated shortage is 226,000 tons per annum), pulses and beans (estimated shortage is 2 million tons per annum), and for mustard and vegetables. The use of concentrated manures is likely to release several million acres from the area under cash crops, like jute and castor and sugarcane, which can then be utilised for growing those food crops and fodder which are needed for the maintenance of positive health of man and cattle.

Approximately 3½ million tons of Ammonium sulphate per annum will be needed to regenerate the land in Bengal to the extent of what is done in advanced countries. The imported stuff is now selling at Rs. 240/ per ton. If the province possessed its own factory, it could be delivered to the peasant at Rs. 80/- per ton. The mobilisation of the factory to produce the above quantity will cost Rs. 70-80 crores, an amount which is not large in comparison with the recurring expenditure of over Rs. 10 crores per annum in the relief and rehabilitation of famine stricken people. Incidentally, it will save the chronic drain of the farmer's money in paying an exorbitant price for the imported product.

(2) The question of the increased production of *milk and milk products and of meat* is not only a costly proposition, but it takes a long time to obtain satisfactory results. The increased production of fish and eggs can be achieved within a shorter period provided scientific methods are followed. The introduction of communal coolers in selected areas and the introduction of freezing, dehydration and canning can prevent a lot of wastage of food which continues to occur in this province in spite of the shortage of food.

It has to be pointed out that milk, fish, meat and eggs are the costliest items in the diet. So long as the purchasing capacity of the population does not adequately improve, most people will not be able to afford to have them in their daily diet. *Technological advance has made it possible to manufacture biological proteins, fats, mineral salts and vitamins in the laboratory at a fraction of the cost of natural foods.* Recent experiments carried out at the Massachusetts Institute of Technology and in the laboratories of the Colonial Food Yeast Ltd. in England and Jamaica indicate the possibilities in this direction. In a country where the pressure on land is great, this is one of the directions in which progress may be looked for. The war has caused tremendous advances in the matter of food supply in technologically advanced countries. It is said that "war sometimes leads to reforms and developments which may take a generation or so to effect in peace-time." With regard to food supply in our country, we are sorry to confess, this statement does not hold good. So long as the Government Agriculture Departments will remain technically inefficient and red-tapism is given preference over the urgency of technical needs, it will not be possible to achieve much progress. It

may be pointed out that an ounce of palatable yeast powder or 3 ounces of processed soya bean and a multi-vitamin tablet per diet can improve the diet of the population of this country to a tremendous extent at a fraction of the cost of that of natural foods.

With a capital outlay of Rs. 7 crores, Bengal can manufacture 650,000 tons of yeast per annum and thus provide for a cheap source of first-class protein and Vitamin B_1 for the entire population. The British Ministry of Food advanced a sum of £150,000 without interest to the Jamaica Food Yeast Co. Ltd. for the production of yeast for the Military and Civil population. Where is the indication of such a venture in our country? If this had been done, thousands of pounds of dried and concentrated milk need not have been imported into India at tremendous cost. Contrast this with the budget for relief and rehabilitation in 1944-45, which has exceeded Rs. 10 crores. Similarly, vitamin tablets at a pice per tablet can be supplied to the population, if arrangements are made to manufacture them with a subsidy from the Government, as has been done in Britain. Bengal's annual requirements of vitamins can be stated as follows: —(1) Vitamin A: Carotene- 60 tons, Vitamin A—30 tons; (2) Vitamin B: thiamin—60 tons, riboflavin—60 tons, nicotinic acid -1200 tons; (3) Vitamin C (ascorbic acid)- 1500 tons; and (4) Vitamin D (Calciferol): one-third ton.

(3) Increased production of *fruits* The science and art of horticulture in Bengal is an almost totally neglected subject. All types of fruits can be grown in various parts of Bengal. It is a matter of regret that while other provinces have gone ahead, Bengal has lagged behind.

The author has not referred to the economic implications of the problem in my comments above. Apart from coordinated action and cooperation between the inter-related departments of the Governments of the Government, the budget of agriculture requires implementation in the following directions: —

(1) Sufficient funds for experimental work, (2) sufficient funds for the manufacture and cheap supply of chemical manures, (3) sufficient funds for a cheap supply of implements and, where necessary, cattle to the peasants, (4) reform of land revenue and tenancy laws, so that peasant owns the land, (5) supply of cheap credit and advance of capital to the peasant whenever necessary, (6) temporary moratorium on all revenue and rent arrears and debts and enforcing gradual payment according to the improvement of agricultural income, (7) guarantee to the peasant that increased production will not mean increased demands by creditors, landlords or Government, at least until his nutritional level is raised to the normal level, (8) guarantee of a fair price to the producers, (9) a minimum wage for agricultural labourers, and (10) free technical assistance to the peasants.

In the course of surveys carried out in some Western Bengal rural areas, it has been noticed that only 10 to 20 per cent of the population can obtain their requirements from land. With barely 2 per cent of the population obtaining their employment from Industry, how are we to offer employment to the remainder? A well-planned and executed programme of public works can employ a proportion of them. The present extent of cottage industries and the income therefrom are not adequate to employ a large proportion of the people. Hence industries or occupations subsidiary to agriculture must be studied and presented before the people so that the present large proportion of the population who are not "gainfully employed" is substantially reduced. This will not be possible without the supply of cheap power to all parts of the province. The province should ultimately aim to absorb approximately 30 per cent of her population in Industry.

Personally the author is against the importation of food from foreign countries as has been visualized at the Hot Springs Conference, except during an emergency, and also is against the importation of so-called foreign experts, which seems to have become a craze in India at the present moment. India has enough scientific talent to cater to the needs of our planning, provided the Government organise a good technical background in their administration and sincerely desire to utilise the best available talents in the country, both at the Universities and in Industry, to solve the cognate problems of nutrition, food production and distribution.

APPENDIX I

DIETETIC REQUIREMENTS AT VARIOUS AGES

(For Bengal)

Sex	Age	Wt. (lb.	Physiological state	Hrs. of work & type of work	Basic Calorie requirement	Addl. Calorie	Total Calorie	Protein (gm.)	Animal	Veg.	Fat (gm.)	Carbohydrate (gm.)	Calcium (gm.)	Phosphorus (gm.)	Iron (mgm.)	Carotene & Vit. A (mgm.)	Vit. B_1 (mgm.)	Vit. B_2 (mgm.)	Nicotinic acid (mgm.)	Vit. C (mgm.)	Vit. D (mgm.)
Female	30	100	Pregnancy 4-9 months	6 hrs. light	2600	300	2900	72	72		70	424	1·5	1·75	15·0	1·5	1·5	2	25	50	25
Female	30	100	Lactating	6 hrs. light	3000	300	3300	62	62		70	544	1·5	1·75	15·0	1·5	1·5	2	25	50	25
Adult male	30	120	...	8 hrs. light	2500	400	2900	30	60		70	475	0·75	1·00	10.0	1·0	1·0	1	10	50	12
Adult male	18	100	..	4 hrs. light	2500	200	2700	37	37		70	444	0·75	1·00	10.0	1·0	1·0	1	10	50	12
Adult male	16	80	...	4 hrs. light	2500	200	2700	44	44		60	452	0·75	1·00	10.0	1·0	1·0	1	10	50	12
Child	12	60	...	4 hrs. light	2400	200	2600	45	15		45	489	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	10	50	..	4 hrs. light	1950	200	2150	33	12		37	409	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	8	45	...	4 hrs. light	1700	200	1900	33	12		33	356	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	6	40	...	4 hrs. light	1500	200	1700	35	15		30	308	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	3	26	...	..	1400	100	1500	39	...		20	291	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	2	22	..	..	1200	50	1250	49	...		16	228	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	1	16	...	...	1100	-	1100	40	...		15	201	1·0	1·25	12·5	1·5	1·5	2	25	50	25

Note: Upto the age of five, most of the protein should be of animal origin, preferably milk. For age period 5 15 years and in expectant and nursing mothers, 50% of the protein requirement must come from animal sources. For adults one-third of the total protein required must come from animal sources. The remainder may be obtained from vegetable sources, such as beans (including soyabeans), pulses, groundnuts, etc.

APPENDIX II

SUGGESTED MENUS FOR BALANCED DIET

(For Bengal)

	A Adult doing moderate work	B Child aged 10 years	C Child aged 5 years	D Child aged 3 years
Parboiled rice	6 chataks	4 chataks	2 chataks	1 chatak
Wheat or other millets	2 ,,	2 ,,	½ chatak	¼ ,,
Pulses	1 chatak	1 chatak	½ ,,	¼ ,,
Egg	Nil	One	Half	One-fourth
Milk	2 chataks	¾ seer	¾ seer	1 seer
Fish or meat	1 chatak*	1½ chataks†	1 chatak‡	¼ chatak (fish)§
Green leafy vegetables	2 chataks	2 ,,	1 ,,	½ ,,
	3 ,,	2 ,,	1 ,,	½ ,,
Fats and oils	1 chatak	1 chatak	1 ,,	½ ,,
Fruits	1 ,, (e.g., 1 banana or orange)	1 ,, (e.g., 1 banana or orange	1 ,, (e.g., 1 banana)	2 ,, (e.g., 2 bananas)

* If fish or meat is not available add 2 chataks of more milk.

† If fish or meat is not available add 3 chataks of more milk.

‡ If fish or meat is not available add ¼ seer more milk

§ If fish is not available, add ¼ more egg.

BOOK REVIEWS

Livestock Improvement.—By J. E. Nichols, Pp. i-vi, 1-208. Oliver & Boyd Ltd., Edinburgh, 1944. Price 10*s*. 6*d*.

As a result of the world war problems relating to livestock development and improvement have assumed special importance. There has been a serious depletion of the livestock resources in most belligerent countries consequent on the large demands of the fighting forces, and the urgent requirements of the civilian populations. Further, during this period of stress and turmoil the work of livestock development was naturally slowed down considerably in almost all countries and production has not been able to keep pace with the demand.

Dr Nichols has had considerable practical experience of livestock management in Western Australia, and, as Deputy Director of the Imperial Bureau of Animal Breeding and Genetics, Edinburgh, is actively engaged in work connected with livestock improvement. In the small handbook under review he provides an excellent summary of the advances made in this field and the lines along which work has been and should be carried out. In the more advanced countries the study and application of the well established principles of genetics have played a very important part in the improvement of livestock, but as the author points out "Formal genetics does not always provide a satisfactory or convenient approach to an understanding of the principles involved in questions of livestock improvement and selection." Its bearings and practical application are at many stages generally beyond the lay breeder. In this handbook an attempt is made to indicate "how genetical and environmental concepts are interwoven in the idea of stock improvement."

Selection and mating system have in the past been the two main tools of the breeder for improving the breeds of his stock. The discovery of the Mendelian System of Inheritance and the realisation of the fundamental basis along which hereditary mechanism operates in any animal from one generation to another have, however, made it imperative that breeders should, if their attempts at improving the breeds are to be successful, have at least a working knowledge of the fundamental facts of genetics. "Inherited units or factors, which instigate or influence the development processes leading to particular characteristics" in the progeny "are termed genes. The facts and problems of inheritance depend upon the ways in which genes are passed on from one generation to another, and upon how genes act and interact." The mechanism of gene transmission is discussed in some detail in the volume, and it is shown that various physiological characteristics of any animal are "dependent upon the expression of a gene complex. This complex has been built up by a combination and interaction of natural and artificial selection so that species and in turn groups of animals, such as breeds, have acquired different kinds of accumulations of gene combinations and frequencies. The form and degree of expression of the physiological traits depend in turn, and to different extents, upon environmental modification and genetical variation."

The main genetical aspects in regard to livestock improvement discussed in the handbook are (*i*) Selection of parents ; (*ii*) Inbreeding as a mating system ; and (*iii*) Line breeding. In subsequent chapters the author discusses Out-Breeding, Cross Breeding, Mating Likes and Unlikes, Performance and Progeny Testing, Breed construction and finally the relationship between Type and Environment, and concludes that "the policy of improvement should be re-examined in relation to the general pattern of the environment, and the appropriate systems, and selection methods chosen according to what is known of their effects."

The general get-up of the work is excellent, and the extensive bibliography should prove very useful for further information on the subject.

B. P.

Antimalarial Drugs.—By Owsei Temkin, M.D., and Elizabeth M. Ramsey, M.D. Publishers: Office of Medical Information, Division of Medical Sciences, National Research Council, Washington, D.C., U.S.A.

This represents a 110-page pamphlet intended to give the general background of present knowledge of the treatment of malaria by drugs. The survey has been fairly comprehensive and almost all drugs which have shown promising results at some time or other in the treatment of human malaria have been noticed. A good bibliography containing all pertinent references has been appended at the end of the report.

Malaria and its treatment is of particular importance to India, as this is still the most outstanding cause of mortality and morbidity in this vast Sub-Continent. Though malaria is one of the few diseases whose epidemiology, incidence, life-history of the

mosquito vector, pathology, etc., are fairly well understood as a result of nearly 100 years of malaria research, its treatment still offers one of the most baffling of all problems to the physicians. In spite of the fact that three very effective antimalarial drugs—quinine, mepacrine and plasmochin—are available to-day to suppress the attacks, malarial relapses cannot be totally prevented. No drug is yet known which can affect the malaria parasite from the time of its entry into the human host following a bite from an infected mosquito (sparozoite stage) to the stage when it attacks the red blood corpuscles. There is room, therefore, for intensified interest being given to continued chemotherapeutic research in this field.

To focuss interest in this direction, the authors have presented a review of the whole field of antimalarial drug therapy starting from cinchona alkaloids to atebrin, plasmochin, sulphonamide compounds, thio-bismol, arsenicals, antimonials, mercurials and amidino compounds, etc. The search has revealed the ground already covered and the obvious gaps which need more attention of research workers. It is a good and timely review of an important topic which can be read with profit by clinicians and research workers alike. The authors have shown a commendable grasp of the subject in presenting this review.

B. M.

The Discovery of the Uses of Colouring Agents in Biological Micro-Technique. —By J. R. Baker. Pp. 1-22. *Monograph of the Quekett Microscopical Club, London*, 1945 (Williams & Norgate Ltd.). Price 1*s.* 6*d.* net.

This historical summary of the use of Colouring Agents or Stains as they are technically known for demonstrating the minute microscopic structure and composition of plants and animals constitutes a very valuable contribution to the subject. It was first published in the *Journal of the Quekett Microscopical Club* (Ser. 4) I, No. 6 (1943), and issued as a revised separate pamphlet in 1945.

The discovery and development of the microscope played a very important part in increasing our knowledge of the structure of various organs and tissues of the plant and animal bodies, but detailed studies of the minute structure of their finer components, the cells, was rendered possible only through the use of colouring agents or dyes technically known as stains. While some of these stains— which are non-toxic—can be used for the study of the living cells and tissues, others are only effective after the tissues have been properly treated and fixed with various reagents. Microtechnique in connection with the preparation of thin slices or sections of tissues for examination with the highest powers of the microscope after proper fixation, staining and mounting in media of definite refractive indices, has developed into a regular science, and it is in this connection that workers will find it useful to have for reference a succinct account of the discovery and uses of various stains.

Dr Baker has classified the use of dyes under six heads: (1) Non-vital dyeing or the colouring of killed or non-living tissue elements by substances which are insoluble in them, but which being absorbed colour these elements, (2) Vital colouring of pre-existent structures or the colouring of pre-existent structures in living cells by dilute solutions of non-toxic dyes, (3) Histochemical colour tests or colour reactions which reveal the chemical composition of the elements, (4) Impregnation with opaque substances resulting in the chemical reduction of a soluble and colourless or pale substance leaving an opaque insoluble residue, (5) Colouring by phagocytosis in which the pagocytic cells become coloured by taking up small particles or colloidal aggregates of coloured substances, and (6) Injection of coloured substances which fill up spaces in organisms either mechanically or by the activities of the living organisms.

In a table the author gives in chronological order the dates of the important discoveries arranged under the six heads from 1714-1896, and in the list of references all important literature has been listed. For the first time this monograph provides a detailed sketch of the history of the subject, and should prove valuable for reference not only by historians of scientific subjects but also by biologists and biochemists in general.

B. P.

Trenching.—By Sam Higginbottom. Published by Kitabistan, Allahabad, Monograph on Agriculture N. 1, p. 15, 1945. Price Nine annas.

Published for the first time in 1918, this revised edition is a timely publication when India is on the threshold of large-scale agricultural development. The author, a Presbyterian missionary, whose pioneering work in scientific agriculture led to the establishment of the Allahabad Agricultural Institute and who spent 41 years in this country, is enthusiastic over the problem of a sanitary and profitable method of disposing off all animal manure including both dung and urine from cattle, sheep, goats, horses, camels, pigs, poultry and elephants both liquid and solid, all kitchen waste and offal, old paper, bone, street sweepings, wood or cow-dung ashes, leaves as dried vegetation and hedge clippings.

The system of dealing with manure and rubbish as explained in this pamphlet was successfully practised at the Government military grass farm, Allahabad, nearly 50 years ago, and by the author at the Naini leper asylum for 33 years. Rotted manure when applied to the soil loses a great deal of fertilizing value, but when trenched a minimum is lost. In the Indian village, the best manure is burnt or piled, with human excreta and vegetable rubbish and often containing plant food of considerable value, causing an incalculable loss to the country.

The cost of trenching, as detailed in the monograph is heavy, but judged in the light of results it is found to be a profitable investment and deserves propaganda amongst the villagers and cultivators.

A. K. G.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.

ON THE OCCURRENCE OF A MIXED INFLORESCENCE IN *ARTOCARPUS INTEGRIFOLIA*, LINN

In the course of an excursion, to the suburbs of Dacca, the writer came across a mixed inflorescence of *Artocarpus integrifolia*, Linn., not recorded previously and which the writer believes to be a new observation.

Artocarpus integrifolia, Linn., is characterised by an oblong inflorescence (spike), having a solid axis (rachis) lined externally by a crowd of very small flowers, either only male or only female. The female inflorescence matures into a multiple spurious fruit known as Sorosis. Fruits, perianth leaves and axis become fleshy and unite into one solid mass. Every conical bit on the skin of the fruit represents a single flower of the inflorescence, from the conglomeration of which the fruit is formed.

There is only one erect stamen in the male flowers (Fig. IIIa). In the female flower there are two medianly placed carpels, the hinder one of which shows various degree of abortion (Fig. IIIb), that is why seeds are not always present in all the fruits as observed by Masters[1] and also by the present writer. Penzig[2] observed in a different species of *Artocarpus* the occurrence of absolutely seedless fruits.

In the specimen collected the writer observed that instead of the usual exclusive male or female inflorescence as recorded by Hooker[3], Prain[4], and Rendle[5] the structure was a mixed inflorescence containing female flowers below and male flowers above, in two distinct and separate zones (Fig. I). The specimen was found after maturity of the flowers and majority of the female flowers were fertilized and was in a developing condition (Fig. II).

Usually after shedding of pollen grains the inflorescence containing male flowers dry up (sometimes also attacked by fungus), and fall off while the inflorescence containing female flowers develop into a big infructescence after fertilization. But here due to the combination of the male and female inflorescence forming a single structure the male portion after shedding their pollen grains dried up and at the same time was also attacked by a fungus (*Rhizopus nigricans*) which developed mycelia and started its

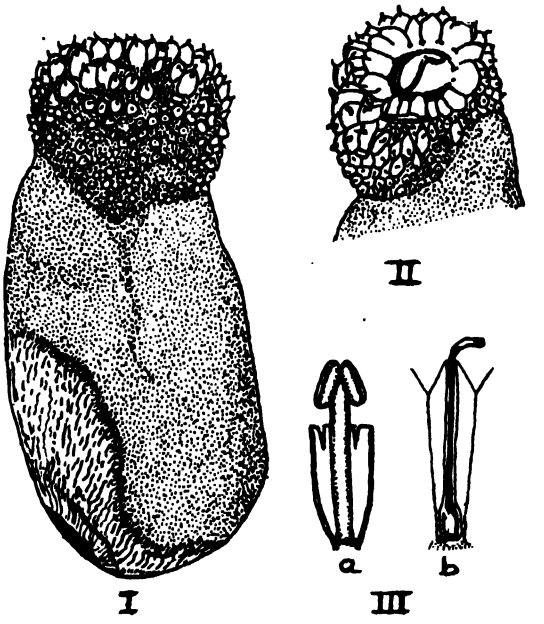


FIG. I. The mature inflorescence with female flowers above and male flowers below. The left bottom of the structure is attacked with fungus with distinct zonations. × Nat. size.

FIG. II. Part of the specimen showing the mature female flowers and the stalk of the inflorescence. × Nat. size.

FIG. III. a. Male flower with perianth split open. ×6. b. L.S of a female flower. ×6.

destructive process (Fig. 1). The female portion after the stimulus of fertilization just started to develop into an infructescence.

MUKARI PROSAD GUHA

Potany Department,
Jagannath Intermediate College,
Dacca, 10-5-1945.

[1] Masters, M. T., Vegetable Teratology, 407, 1868.
[2] Penzig, O., *Pflanzen Teratology*, 3, 219, 1922.
[3] Hooker, J. D., *The Flora of British India*, 5, 539, 541, 1890.
[4] Prain, D., *Bengal Plants*, 2, 970, 1903.
[5] Rendle, A. B., *The Classification of Flowering Plants*, 2, 51, 1938.

ADULTERATION OF BROKEN RICE AND FLOUR WITH SILICEOUS MATTER

IN the course of our investigation on the de-infestation of grains and flour, we had occasion to examine several samples of broken rice and flour which are now listed among the rationed articles.

The broken rice presented some unusual features. Apart from infestation with insects and fungi, it contained quite a high percentage of foreign matter possessing nearly the same colour as the rice itself. A small part of it was quartz, which had been apparently crushed to a size corresponding to the broken rice itself. There was also some whitish coloured clay matter in the form of shreds, again corresponding in size to the broken rice. This appeared to be rather too much of a coincidence and on examination we found that the broken rice contained, on an average 22 per cent of ash, represented mostly by silica. This is admittedly a very high figure particularly when considering that the rice was practically free from paddy husk.

We have also recently examined specimens of flour, particularly wheat flour, containing a high percentage of silica. This again does not appear to have been fortuitous.

Apart from having to pay a high price for the food materials, it is very unfortunate that the public should be compelled to consume a good deal of foreign matter which is bound to prove injurious in such large quantities. Broken rice is largely consumed by the poor people in South India. It is sold at a lower price than whole rice, but it would be most unfortunate if the poor people are given a large amount of stone in place of rice.

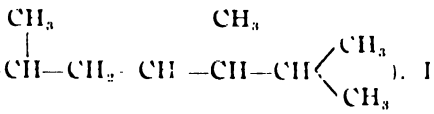
There does not at present appear to be any systematic analytical control in regard to such food articles. It is possible that the sellers produce some kind of certificate, but the provinces and States buying such articles should have an independent check on the composition. As the public have practically no choice in regard to the selection of the food articles rationed out to them, it would seem to be doubly important that there should be some kind of State control to see that gross adulteration of the above type does not take place. Provincial Governments and the State being the bulk purchasers should exercise the necessary control to see that the interests of the people whom they represent are adequately safeguarded. This could be done by fixing food specifications and penalysing the suppliers whose articles do not conform to the specifications.

C. N. BHIMA RAO
V. SUBRAHMANYAN

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 15-5-1945.

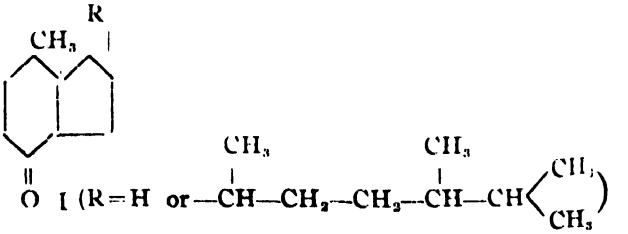
SYNTHESIS OF 8-METHYL-0:3:4-BICYCLONONANE-4-ONE

IN a study of two addition products of Vitamin D_2 with maleic anhydride, Windaus and Thiele[1] observed that dihydroderivatives of the above adducts, obtained by the saturation of the double bond in the side chain on ozonisation yielded a saturated ketone of the composition $C_{19}H_{34}O$, to which they assigned the structure (I, R



). Later Dimroth and Jonsonn[2] also obtained a stereoisomer of the same ketone by a different route. The importance of the synthesis of the above type of ketone can hardly be overestimated in view of the fact that quite recently processes[3] have been developed, which can be made use of in building up the Vitamin D_2 molecule starting from the above ketone.

In this connection, as a preliminary study, we have been able to synthesise 8-methyl-0:3:4-bicyclononane-4-one (I, R = H) by the following method.



Sodio-derivative of ethyl 2-methyl-2-carbethoxycyclopentylcyanoacetate was condensed with ethyl β-bromopropionate and the resulting ethyl β-carbethoxyethyl-2-methyl-2-carbethoxycyclopentylcyanoacetate (b.p. 195-197°/4-5 mm.) was hydrolysed by prolonged refluxing with concentrated hydrochloric acid to yield α-(2-methyl-2-carboxycyclopentyl)-glutaric acid (m.p. 189-192°). Triethyl ester (b.p. 175-176°/5 mm.) of the acid smoothly underwent Dieckmann's condensation in presence of metallic sodium to give diethyl 8-methyl-0:3:4-bicyclononane-7-one-4:6-dicarboxylate (b.p. 200°/12 mm.). For the subsequent hydrolysis, the above β-ketonic ester was refluxed in the crude state with 20% sulphuric acid and the resulting 8-methyl-0:3:4-bicyclononane-7-one-4-carboxylic acid, which was purified by vacuum distillation (b.p. 182°/5 mm.), solidified (m.p. 95-96°, semicarbazone m.p. 217°). The above keto-acid was reduced by Clemmensen's method, when 8-methyl-0:3:4-bicyclononane-4-carboxylic acid (b.p. 156-158°/8 mm.), which was obtained as a colourless oil, was converted through its acid chloride followed by bromination and esterification into ethyl 8-methyl-4-bromo-0:3:4-bicyclononane-4-carboxylate (b.p. 142-144°/8 mm.). The above bromo-ester, on being refluxed with alcoholic potash, yielded 8-methyl-0:3:4-bicyclononane-Δ^4-ene-4-carboxylic acid (b.p. 161°/8 mm.), which on treatment with sodium azide gave rise to 8-methyl-0:3:4-bicyclononane-4-one (b.p. 92-94°/8 mm., semicarbazone, m.p. 185-186°).

Our thanks are due to Prof. P. C. Mitter for the interest he has taken during the progress of this work. Authors are greatly indebted to Prof. S. N. Bose of Dacca for his valuable advice. Thanks are also due to Mr N. Ghosh M.Sc. for carrying out microanalysis of the above compounds.

P. Bagchi
D. K. Banerjee

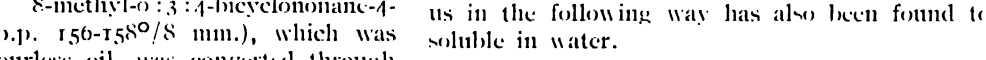
Sir P. C. Ray Research Fellow's Laboratory,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 25-5-1945.

[1] Windaus and Thiele, *Ann.*, *521*, 160, 1935.
[2] Dimroth and Jonsonn, *Ber.*, *74B*, 520, 1941
[3] Aldersley, Burkhardt, Gilman and Hindley, *J. C. S.*, *10*, 1940; *Cf.* Aldersley and Burkhardt, *J. C. S.*, 545, 1938; Milas and Anderson, *J. Am. Chem. Soc.*, *61*, 2534, 1939. Dimroth *et al.*, *Ber.*, *75B*, 189, 322, 326, 510, 582, 1263, 1942; *Ibid.*, 317, 1943.

SYNTHESIS OF 4:4′ DI(AMINO METHYL)-DIPHENYL SULPHONE,—A HIGHER HOMOLOGUE OF 4:4′ DIAMINO DIPHENYL SULPHONE

The antistreptococcal activity of 4:4′ diamino-diphenyl sulphone was found to be approximately one hundred times that of sulphanilamide.[1] Moreover, it has been found to possess inhibitory action against experimental tuberculosis in animals, but its high toxicity precludes its use in clinical tuberculosis in man.

The present investigation was undertaken with the object of obtaining a compound of low toxicity but possessing higher antistreptococcal and antitubercular activity than 4:4′-diamino-diphenyl sulphone. Recently the higher homologue of sulfanilamide has come into prominence as 'Marfanil'. It has a much higher activity than sulfanilamide with the additional advantage of its solubility in water. 4:4′-Di(aminomethyl) diphenyl sulphone prepared by us in the following way has also been found to be soluble in water.



4:4′-Dimethyl diphenyl sulphone[2] m.p. 158° was brominated in the side chain to give 4:4′-di(bromomethyl) diphenyl sulphone m.p. 199°[3]. The dibromo compound was condensed with potassium phthalimide in the usual way. The phthalimdo complex crystallised from glacial acetic acid and melted at 272° (found C 66·4%, H 3·6%, formula, $C_{30}H_{20}N_2O_6S$ requires C, 67·1%, H, 3·7%). It was treated in alcoholic suspension with hydrazine hydrate and then with hydrochloric acid. The diamine obtained in the usual way, crystallized from benzene and melted at 125° (found N 9·89%, formula $C_{14}H_{16}SO_2N_2$ requires N, 10·01%). The dihydrochloride crystallised from dilute alcohol did not melt even at 320° (found C, 48·5%, H, 5·23%; formula $C_{14}H_{18}N_2SO_2Cl_2$ requires C, 48·1%, H, 5·1%).

My thanks are due to Prof. P. C. Mitter for his valuable advice and encouragement during the course of the investigation and to Messrs. N. Ghosh and S. Ghosh for microanalyses of the samples.

Munindra Chandra Sen Gupta.

Palit Laboratory of Chemistry,
University College of Science
and Technology, Calcutta.
6-7-1945.

[1] Buttle, Stephenson, Smith, Dewing and Foster, *Lancet*, *I*, 1331, 1937.
[2] Otto and Beckurts, *Ber.*, *11*, 2068.
[3] Genvresse, *Bull. Soc. Chim.*, *37*, 9, 707.

LIFE HISTORIES OF SOME CARNIVOROUS FISHES OF BENGAL

Life-histories of important carnivorous fishes of Bengal are still not recorded. This chart will give an opportunity to compare with some fragmentary data already known for workers in this line. The study of such fishes have been made in connection with the scheme under I.C.A.R. The details will be published elsewhere.

	Anabas testudineus.	*Notopterus notopterus.*	*Ophicephalus punctatus.*	*Wallagonia attu.*
Breeding season.	Middle of April to Middle of June.	May to July.	June to August.	June to August.
Spawning ground.	Paddy field and seasonal ponds.	Inundated bed of ponds near embankments	Rice field and ponds in specially built nest.	Inundated fields and *bundhs*.
Nature of eggs.	Floating.	Demersal with adhesive substance on the egg membrane.	Floating. Float at the centre of the nest.	Demersal.
Size of the eggs after swelling.	0·7 mm.	3·5 mm.	1 mm.	1·2 to 1·5 mm.
Segmentation.	Regular	Regular.	Regular.	Regular
(*a*) 8 celled stage.	45 mi. since fertilisation.	40 mi. since fertilisation.	Time variable and depends greatly on the intensity of Sun rays.	45 mi. since fertilisation.
(*b*) 16 celled stage.				
(*c*) 32 celled stage.	1 hr. 50 mi. fertilisation.	1 hr. 10 mi. since fertilisation.		1 hr. since fertilisation.
(*d*) Many celled stage.	2 hrs. fertilisation.	Segmentation cannot be followed.		Segmentation cannot be followed.
Completion of yolk invasion and formation of blastopore.	9 hrs. after fertilisation.	1 day 20 hrs. 20 mi. since fertilisation.	About 7 hours since fertilisation.	7 hrs. since fertilisation.
Appearance of embryonic rudiment.	10 hrs. after fertilisation.	2 days, 18 hrs. 20 mi. since fertilisation.	About 8 hours since fertilisation.	8 hrs. since fertilisation.
Appearance of the optic rudiment.	12 hrs. 45 mi.	4th day.	About 12 to 15 hours since fertilisation.	9 hrs. 30 mi. since fertilisation.
Appearance of heart rudiment.	13 hrs. after fertilisation.	6th day after fertilisation.	About 15 hours since fertilisation.	15 hrs. 30 mi. after fertilisation.
Appearance of gill rudiment.	24 hrs. since hatching.	Do.	24 hrs. since hatching.	12 hrs. since fertilisation.
Appearance of pectoral fin bud.	9 hrs. since hatching.	7th day after fertilisation.	12 to 15 hours since fertilisation.	31 hrs. since fertilisation.
Appearance of otocyst rudiments.	15 hrs. since fertilisation.	5th day ,, ,,	12 to 15 hours since fertilisation.	14 hrs. 30 mi. since fertilisation.
Period of incubation.	18½ to 20 hrs.	9 days.	About 1 day. In aquarium about 4 days.	15 hrs. 20 mi. since fertilisation.
Length of newly hatched larva.	1·9 mm.	8·5 mm.	3·1 mm.	4 mm.
Appearance of median fin-fold.			12 to 15 hours since fertilisation.	14 hrs. 30 mi. since fertilisation.
Beginning of pulsation.	16 hrs. since fertilisation.		16 to 17 hours since fertilisation.	
Appearance of dorsal fin rudiment.		3rd day after hatching.		
Appearance of pelvic fin rudiment.		11th day ,, ,,	6 to 7 days since fertilisation.	7 days since fertilisation.
Appearance of anal fin rudiment.		11th day ,, ,,		

	Anabas testudineus.	*Notopterus notopterus.*	*Ophicephalus punctatus.*	*Wallagonia attu.*
Appearance of scales.	15 days after hatching.	13th day after hatching	about 2 weeks after hatching.	absent.
Appearance of barbels.	absent.	6th day ,, ,, (Maxillary barbels)	absent.	14 hrs. 30 mi. since fertilisation.
Appearance of liver	12 hrs. after hatching.			
Appearance of air bladder.	24 hrs. ,, ,,			
Fry.	Ten colour bands are visible, premaxillæ provided with small pigment dots; depressions in inter orbital and occipital regions, scales on head. Posterior edge of the operculum is spinate.	Pelvic fins jointed to a certain extent along the inner side from the base and free distally, number of bands reduced to 19.	Mouth upturned, scales on the head; Dorsal and ventral margins of the body highly pigmented.	Head very much depressed; snout is spatulated; barbels present, fins with rays, caudal fin deeply forked, lateral line prominent, toothed.
Habitat of the adult.	Same as W. attu.	Fresh and brackish waters of India.	Fresh water of India, Burma, Ceylon and Africa.	Fresh waters of India.
Habit.	Carnivorous.	Carnivorous.	Carnivorous.	Carnivorous and harmful to fish fry and small fishes.
Parental care.	Not found.	Parental care generally develops upon the male which can be easily caught.	Both male and female guard the nest and fry till the offsprings are sufficiently old.	Not found.

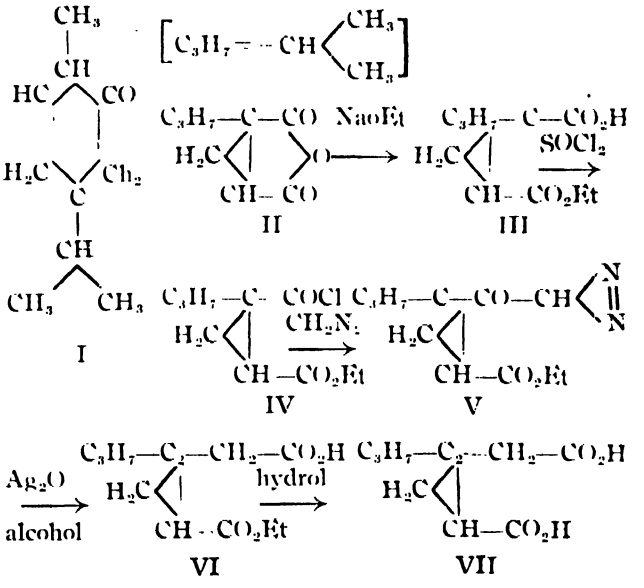
Department of Zoology, Calcutta University,
35, Ballygunge Circular Road,
Calcutta, 31-5-1945.

H. K. MOOKERJEE

TOTAL SYNTHESIS OF THUJONE

THUJONE (I), the naturally occurring bicyclic terpene ketone occurs fairly widely in nature. It has been isolated from thuja oil, sage oil, tansy oil, worm wood oils, etc. The constitution of thujone has been a subject of keen study by several authors, notable among whom are Wallach, Semmler, Ruzicka, etc. The constitution is known with a fair degree of certainty from a study of its degradation products, but no total synthesis either of the ketone or of its degradation products has yet been achieved.

Ruzicka and Koolhass[1] effected a partial synthesis of thujone starting from thujaketonic acid, the immediate degradation product of thujone, analogous to their synthesis of pinacamphone from pinonic acid.[2] Thujaketonic acid having been synthesised from the anhydride of α-thujadicarboxylic acid,[3] and synthesis of umbellularic acid[4], a lower homologue of thujadicarboxylic acid having been already achieved, it only remains for the total synthesis of thujone, to synthesise thujadicarboxylic acid from umbellularic acid. This synthesis has now been accomplished according to the scheme outlined below:



The mono-ester (III) derived from umbellularic anhydride (II)[4] yielded the mono-ester mono-acid chloride (IV) with thionyl chloride. The acid chloride with diazomethane gave the diazoketone (V) which with Ag_2O in alcoholic suspension rapidly lost nitrogen. The nitrogen-free product after hydrolysis with sodium carbonate solution yielded an acid melting at 80-81°C to which the constitution of isomeric thujadicarboxylic acid was tentatively assigned[5] by us. Careful fractional crystallisation of the acid melting at 80-81° revealed it to be a mixture of thujadicarboxylic acid (VII), m.p. 138-39° and umbellularic acid, m.p. 95°. Mixed melting point of the synthetic thuja-dicarboxylic acid with a genuine sample of α-thujadicarboxylic acid, prepared by oxidation of thujone remained undepressed. Equivalent weight determination and combustion values agree well with the values theoretically required (Found: Eq. Wt. 92·92; C, 57·94; H, 7·55. $C_9H_{14}O_4$ requires Eq. Wt., 93·0; C, 58·06; H, 7·53 per cent).

M. S. Muthanna
P. C. Guha.

Organic Chemistry Laboratories,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 22-6-1945.

[1] Ruzicka and Koolhass, *Helv. Chim. Acta.*, *15*, 944, 1932
[2] Ruzicka and Trebler, *Helv. Chim. Acta.*, *4*, 666, 1921.
[4] Guha and Muthanna, *Ber.*, *71*, 2671, 1938.
[5] Ranganathan, *J. Ind. Chem. Soc.*, *13*, 419, 1936; Simonsen *et alia*, *J. C. S.*, 828, 1936; *Rydon*, *Ibid.*, 829; Guha and Muthanna, *Ber.*, *71*, 2668, 1938.
[6] Guha and Muthanna, *J. Ind. Inst. Sci.*, *22A*, XXII, 275-285, 1939.

SCIENCE AND CULTURE

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A PLEA FOR THE REORGANIZATION OF BOTANICAL SURVEY OF INDIA

IN recent years, great progress has been made in the investigation of the vegetable resources of almost all progressive countries of the world, particularly those involved in the World War II which fortunately for mankind has at last come to an end after six years of terrible bloodshed. The need of fully utilizing plants and plant products for food, medicine and industrial purposes was never before felt so much in the history of the world. Different nations are vying with each other in the campaign for *Growing More Food*, betterment of its nutritive value and storage by modern methods including dehydration. Increase in the quantity and quality of crops is based on the results of intensive researches in pure and applied sciences carried on in the different agricultural, botanical and horticultural institutions. In some countries, specially Russia, University workers, Government officials, and non-official scientists all put their head and heart together as members of one family in order to raise the standard of food production.

A glance over the activities of the old and recently established Russian institutions as outlined in the article entitled "Institutions under the U.S.S.R. Academy of Sciences" by M. N. Saha and S. N. Sen, published under "Biological Sciences" in SCIENCE AND CULTURE, August 1945, Vol. XI, No. 2, reveals what an amazing forward step has been taken in Russia to better the economic well-being of her people in spite of their life and death struggle to preserve freedom and integrity of the nation.

Important botanical investigations have been carried out in recent times even in China, which has been engrossed in the war for many years. Botanical exploration has continued and important works like the 'Flora of Fukien' by Metcalf (1942) and 'Icones Plantarum Omeiensium' by Wen-fei-Fang have been published.

In the United States of America, Dr B. A. Krukoff and his collaborators are doing intensive researches on tropical plants including a large number of Indian plants for manufacturing insecticides and insect-repellents. On the pure systematic side which has a great bearing on the applied aspects of botanical and agricultural investigations, voluminous works are being produced as a result of botanical explorations in different parts of the world on different classes of plant kingdom by Prof. E. D. Merrill, Administrator, Botanical Collections, and his associates in the Harvard University, Arnold Arboretum, New York Botanical Garden, Smithsonian Institution and other botanical institutions of U. S. A. Vigorous attempts are being made to collect botanical materials, both dried and living, from different parts of the world, including India and Burma, to enrich the herbaria of botanical institutions, Universities and botanical gardens in the United States of America.

In his article on 'The New Systematics of Cultivated Plants', the distinguished Soviet botanist Vavilov* remarks:

"The Flora of Cultivated Plants of the U. S. S. R. which we have started to publish is a first attempt at a critical survey of the diversity of varieties of important crops on a world scale. Wheat and potatoes give us a good example of how complicated evolution is. From Friedrich Kornicke's very simple scheme of classification of cereals, published in 1885 in his *Handbuch des Getreidebaues*, we are proceeding farther and farther with the opening up of new continents of varieties. Recent detailed studies of Chinese wheats have led us to the necessity of establishing

* We were sorry to learn that Vavilov died about two years ago.—Ed. SCIENCE AND CULTURE.

new complex Linnean species, differentiated into a great number of botanical varieties unknown in other parts of the world, although of secondary origin. By crossing different types within the same morphological species, genetical differences have been established. Hybrids between different durum wheat types proved to be sterile. Cyclic crosses showed definitely the appearance of many lethals in crosses between Indian and European types of soft wheat."

"Plant breeding requires for its purposes not only a knowledge of morphological botanical varieties but also a knowledge of their differentiation into ecological and physiological groups. What interests plant breeders more than morphological characters are differences in resistance to drought, to cold, to various fungi, bacteria, viruses, and insects, and also biochemical differences between varieties. The needs of practical plant-breeding have brought us to the elaboration of a new, agro-ecological classification of intraspecific diversity on a world scale, as far as this has been possible for us. This work could only be accomplished with the aid of what we call 'geographical sowings' in different regions, studying the same varieties (collected from all parts of the world) under different conditions, examining their reaction to different parasites, to various environmental conditions."

In these days of scientific advancement, therefore, no one with any pretence to education can dispute the value and necessity of intensive botanical survey of unknown and little known regions of the world. In fact, botanists look for the earliest opportunity to discover new species, varieties or forms of plants for crossing and hybridizing purposes with a view to improving crops, fruits, timber, flowers, pastures, fibres, gums, oil-yielding plants, medicinal plants and various other plants used for economic purposes. Prof. Vavilov has rightly stressed upon the improvement of the vegetable wealth of the world by proper exploration in the following statement:—

"Some biologists are of the opinion that the age of classical systematics is at an end. From our personal experience we have come to the conclusion that even for cultivated plants, such as wheat, potatoes and fruits, this is not quite so. For there are vast areas in South America, Central America and Southern Asia with enormously rich floras, which have not yet been studied even superficially. If we say this from our experience with cultivated plants, it is still more applicable to wild floras. Thousands and thousands of new species are yet to be discovered. And the lack of even such superficial knowledge is a great hindrance to our general understanding of the flora and fauna of the world. The basic biological work, which must embrace a knowledge of the entire flora and fauna of the world, is not yet finished, even in its first approach, *i.e.*, in the Linnean understanding of species. But from what we have already said here it is sufficiently clear that we regard classical systematics, which works only with Linnean species, as merely a first step in biological knowledge and quite superficial for the purposes of practical plant and animal breeding. Nor does it satisfy requirements of a thorough study of species from an evolutionary point of view."

"We are now entering an epoch of differential, ecological, physiological, and genetic classification. It is an immense work. The ocean of knowledge is practically untouched by biologists. It requires the joint labours of many different specialists—physiologists, cytologists, geneticists, systematists and biochemists. It requires the international world. The most remarkable regions of the world, the cradles of primitive civilizations—the mountainous regions of Southern Asia, Central and South America—are still in need of investigation even as to their resources of cultivated plants and domestic animals."

"We do not doubt that the new systematics will bring us to a new and better understanding of evolution, to a great increase in the possibilities of governing the processes of evolution, and to great improvement in our cultivated plants and domestic breeds of animals. It will bring us logically to the next step: integration and synthesis."

The need for floristic studies from pure and applied standpoint was so much felt in Russia that reorientation of their botanical institutions has recently been made by the authorities as quoted by Saha and Sen:

"Facilities for the study of biological and botanical sciences under the Academy were greatly increased after 1929, when the main Botanical Gardens in Leningrad, formerly under the People's Commissariat of Agriculture of the R. S. F. S. R. (Russian Socialist Federated Soviet Republics), were transferred to the U. S. S. R. Academy of Sciences. These gardens were founded in 1714 by Peter I. The Academy had the Botanical Museum which was merged with the newly transferred Botanical Gardens."

"From these two institutions has emerged the famous *Botanical Institute of the Academy*, which, in 1940, was renamed the Komarov Botanical Institute in honour of Vladimir Komarov, President of the Academy. The Institute's herbarium contained about 5 million specimens in 1943. The library of the Institute, containing more than 135,000 volumes which include the most important literature on the subject of botany since the 15th century, is one of the best libraries in the world."

A comparison with these activities towards the expansion of botanical institutions and gardens in Russia and elsewhere with those in India shows that the floristic investigation in India is in a deplorable state of stagnation. In India, certain quarters even suggest the *suicidal policy* of separating the Herbarium from the Royal Botanic Garden at Sibpur, whereas in Russia and other leading countries *amalgamation of the herbaria and laboratories with the garden for proper study of all aspects of plant life in the field and the herbarium is considered indispensable.*

Royal Botanic Garden, Sibpur

The greatest event in the history of botanical research in India is no doubt the foundation of the Royal Botanic Garden in Sibpur, near Calcutta (1787).* This was made possible through the ex-

* The Sibpur Garden founded in 1787 soon became the East India Company's garden and remained under the jurisdiction of the Governors-General of Fort William in Governor of Bengal, and it has since then remained so. With the creation of Botanical Survey of India in 1887, Government of India revived its interest in the Garden. (See Appendix).

ertion of Col. Robert Kyd who was a keen horticulturist. With the establishment of the Botanic Garden, a recognized centre of botanical activity in India was formed, and with it began an association of a series of very brilliant botanists to whom we cannot but look up with gratitude and respect. The original object in the establishment of the garden was the introduction of new economic plants and their acclimatization on Indian soil, and considerable progress was made in this direction. A few examples may be given.

The tea industry in India was established through the efforts of the Sibpur botanists. Sir Joseph Banks in 1788 recommended to Warren Hastings experiment on tea cultivation in North Bengal. Later in 1826, David Scott discovered that tea grew wild in the forest of Assam and in 1835 Wallich, Griffith and McClelland (officers of the Botanical Garden, Sibpur) were deputed by Lord William Bentinck to visit Assam and report on the indigenous tea, and as a result of their efforts the tea industry was established in India. Expenses for the Indian Tea Commission and another mission to China to study the cultivation there cost Government of India about Rs. 2,70,000.

The history of the introduction of rubber into India is quite interesting. In 1876, H. A. Wickham, without any authority, pledged the credit of the Government of India to charter a new ship, and before the Brazilian Government could know of anything, smuggled out from the mouths of the Amazon, a good quantity of the seeds of *Hevea*. He brought these to Sir Joseph Hooker at Kew. These were grown in the Orchid Houses at Kew and then supplied to India, Ceylon and Singapore. In 1877, seeds were sent to Mergui by Sir George King of Botanical Garden, Sibpur and considerable efforts were made by him to organize para-rubber plantation in Kurseong, Jalpaiguri and Buxa, but the reports were not favourable.

Sir Clements Markham was the actual collector who pushed into the forests of Peru and Ecuador and at a great personal risk brought back young plants and seeds of quinine-yielding cinchona which were raised in thousands at Kew for distribution. After the Dutch had naturalized cinchona in Java, Lady Canning deputed Dr Thomas Anderson (of Sibpur Botanical Garden) to Java, who brought a large consignment of plants to Darjeeling and acclimatized them in Sikkim Himalayas. Later, through the exertions of Sir George King, cinchona cultivation and manufacture of quinine were made a commercial success.

By the introduction of some of the best kinds of sugarcane from the West Indies and the dissemination of these to all parts of the country, a considerable improvement was effected both in the quality and quantity of the sugarcane crop of the country by the Sibpur botanists.

Other plants experimented upon, on their cultivation, are flax, hemp, ramie, tobacco, sarsaparilla, coffee, mulberry, cardamom, cocoa, ipecacuanha, aloes, cannabis, etc. It is obvious that the results of exploration and subsequent systematic studies of plants collected, for experimental cultivation and chemical investigation in the past, by the staff of the Royal Botanic Garden, Sibpur, led to the discovery of some of the most important economic plants in India in the last century.

In the improvement of Indian cotton and in the introduction of jute to the markets of Europe, the Sibpur Garden authorities worked hand in hand with the Agri-horticultural Society of India. Bengal (Dacca) Cotton (a variety of *Gossypium herbaceum*) was one of the finest cotton in the world, providing cloth of astonishing beauty and fineness. The plant was annual and afforded two crops in the year (April and September), in the districts of North-West Dacca, and the favourite sites were the high banks of the Ganges and its tributaries. The fibre of this cotton (*bairali kupa*), was extremely fine, silky and strong and admirable for the manufacture of muslins and thinner fabrics. Roxburgh in his 'Flora Indica' (1832) gives the points of difference between the ordinary Bengal and special Dacca cotton and the MS. plate of the plant is in the herbarium of the Royal Botanic Garden, Sibpur. *No attempt has so far been made to re-discover this Dacca variety of Bengal cotton* which appears to have disappeared and Bengal, which once supplied the world with cotton fabrics manufactured out of the cotton grown on her own soil, is declared to be unsuitable for the growth of cotton plants! It is clear that attempts should be made for the re-discovery of the plant.

Of recent introduction is the Tung oil plant (*Aleurites montana*), a source of oil so useful for various industrial purposes.

The Sibpur botanists have also taken a leading part in another economic enterprise of the Government *viz.*, the Forest Department. Introduction of exotic trees received attention and in the garden there still remain a few of the original mahogany trees introduced in the early years. Cultivation of teak tree was also begun on a large scale and continued for 35 years, when it became clear that on the muddy soil of the Gangetic delta, teak stems early become hollow near the base and therefore incapable of yielding sound timber.

Recent Russian Work on Botanical Explorations

The example set in recent years by the Soviet workers working under the guidance of Vladimir

Komarov, President, U.S.S.R. Academy of Sciences, Vavilov and other academicians, should serve as a guide to what could be achieved even now by explorations and expeditions in India and elsewhere.

In recent years, in their hunt for rubber-yielding plants, the Russians have discovered *Taraxacum Kok-saghyz*, (a dandelion) in the Tian-shan mountains, whose roots produce rubber of great potential value. The history of this plant has been closely interwoven with the destiny of many millions of Soviet people and in the present war, Russians are commercially extracting rubber from this plant.

The discovery of perennial wheat by the Russian agronomist, Nikolai Tsitsin, Director of the Moscow Botanical Garden, is of very great importance for a world that often goes hungry. The new wheat is a hybrid, between wheat and couch grass (*Agropyron repens* Beauv). Tsitsin has also treated the rye in the same way. If wheat and rye can be so treated, why not rice, millet and other cereals? Tsitsin made 30,000 trials before he found success.

"Explorations by Russians in Central Asia and Caucasus have led to the discovery of numerous wild and semi-cultivated varieties of plums, apricots, peaches, almonds, cherries, apples, pears, grapes, walnuts, etc. Most of these varieties were previously unknown to science and are endemic in these regions. Many exhibit great hardiness, resistance to drought, frost and several diseases. Some also show good quality and flavour. For these reasons they have proved of great value in breeding work. As a result of these discoveries large areas in Soviet Union, formerly barren, have been brought under cultivation and turned into profitable orchards.

Three out of the eight 'primary centres' or origin of the cultivated plants recognized by Russian workers border India. These are (1) Central Asia (2) mountains of Eastern and Central China and (3) Indo-Malayan region. India is therefore in an exceptionally favourable position to organize the exploration of the wild forms of the old world fruit trees. This may greatly help in extending the area under cultivation in this country and improving the quality of the fruits already under cultivation."

Work in U.S.A. and Latin America in recent years also deserves mention. *Parthenium argentatum* (Guayule plant), a desert weed, which grows wild in Mexico, is now being intensively cultivated in U.S.A. under Government direction for vegetable rubber. The history of its discovery is instructive.

The Cinchona Mission in South America surveyed recently a considerable area in the mountains of South America in search of other wild species of cinchona having minimum alkaloid content. Several new species were discovered by the technical aid of botanists and chemists of this Mission, during the World War II.

Progressive Extinction of Botanical Survey in India

No planned and systematic survey of any part of India could be undertaken in recent years owing to the absence of funds, etc. There is no denying the fact that even the unlimited vegetable resources of this country are not yet properly explored and to carry on this investigation it is imperative and urgent that the botanical survey should be re-organized. Unless the survey is brought to its proper footing, India will lose a great market in the future. Future India looks forward to a better and higher standard of living for her millions of tillers of soil and she needs more vegetable raw materials to foster her developing industries.

The Cryptogamic flora (*viz.*, algae, lichens, mosses, ferns) of this country which may lead to valuable discoveries of great economic importance is still left almost untouched. (Late Sir Edwin Butler was appointed the Cryptogamic Botanist in 1901 at Sibpur, but he was soon transferred to Dehra Dun and later became the Imperial Mycologist at Pusa. Since then, there has been no appointment to the post of cryptogamic botanist in the botanical survey!) The survey of marine algae along the shores of the Indian empire and those in the Chilka Lake may supply sufficient raw materials for profitable industry in agar agar and iodine.

The Botanical Survey of India (see Appendix) as at present constituted is unable to cope with such enormous work which promises a bright future for the country. In their Annual Reports, successive directors referred to the rapidly accumulating mass of collections, exceeding the capacity of the staff to deal with them in detail.

Attempts to expand and re-organize the botanical survey made from time to time have so far failed. A sub-committee appointed at the thirty-sixth meeting of the Board of Scientific Advice of the Government of India in 1910—to consider proposals for the re-organization of the botanical survey—consisting of Col. Gage and others recommended *inter alia*:

(1) The Government of India to take over the Royal Botanic Garden, Sibpur with its herbarium and library.

(2) The herbarium and library of the botanical survey, at present in the Indian Museum, to be transferred to and amalgamated with the herbarium and library of the Royal Botanic Garden and herbarium building to be enlarged.

(3) A research laboratory to be built in the Royal Botanic Garden.

(4) The public galleries of the industrial section of the Indian Museum (under the botanical survey) to be retained where they are and developed under the charge of a highly qualified staff.

(5) The staff of the botanical survey to be enlarged as rapidly as possible to the scale and on the pay indicated.

The recurring expenditure was estimated to be Rs. 4,50,000 per year.

The proposals submitted by the Board were accepted by the Government of India but their implementing was postponed on account of financial stringency. The staff of the Botanical Survey was, however, strengthened to some extent in 1910. This staff carried on the routine work of the department. There was a set back of the Department later on, when sometime in 1927, the exploration grant was stopped and subsequently in 1931-32 one of the systematic assistants (out of two) was retrenched as a measure of economy and the Gage Committee's report was pigeon-holed!

Indian Scientists demand revival of Botanical Survey

The question of the re-organization of the Botanical Survey was next considered by a Committee of the Botany section of the Indian Science Congress Association at its Jubilee Session in 1938. The conclusions arrived at by this Committee had the approval of the late Sir Arthur Hill, Director, Royal Botanic Gardens, Kew, London, who attended this meeting by special invitation.

Their recommendations were:—

(1) The industrial section* of the Indian Museum should be maintained as a separate department of the Government of India and the scope of its exhibits expanded so as to illustrate in a readily intelligible form the outlines of botanical science in general and the vegetation of the Indian Empire and its chief economic vegetable products in particular. The herbarium of this section should be developed as a special herbarium for economic botany. For this purpose, the appointment of scientific assistants on the staff of the Museum is necessary.

(2) The headquarters of the Botanical Survey should be located at the Royal Botanical Garden and the Sibpur Herbarium should be developed as the '*National Herbarium*' for India.

* It may be recalled, that this section organized in 1883 by late Sir George Watt, as Reporter of the Economic Products to the Government of India, led to the establishment of a magnificient museum of economic products in the Indian Museum and the compilation of the monumental work entitled '*Dictionary of Economic Products of India*, Vols. I–VII'. In connection with the preparation of the dictionary there had been established in that office, which have come to be officially known as 'ledgers'. These consist of books of blank paper assorted within boxes, according to the names of the products in India. Into the books have been pasted cuttings from numerous publications, in sequence of date and it is thus easy to ascertain all new particulars. If this department was re-organized on the lines, as indicated above, the revision of Watt's dictionary, which is now being done by the Council of Scientific and Industrial Research (now under the Department of Planning, Government of India) would have been placed under the Botanical Survey.

(3) The Government of India should take over the Royal Botanic Garden and the Herbarium at Sibpur, the Bengal Government making a suitable contribution for the maintenance of the Garden.

(4) The permanent scientific staff of the Botanical Survey thus re-organized should be strengthened.

(5) The co-operation of the staff of Indian Universities in working out collections and in conducting Botanical Survey of the unexplored parts of the country is to be enlisted.

(6) Provincial herbaria for the following areas, *viz.*, (*a*) Madras Presidency, (*b*) United Provinces and Bihar, (*c*) The Punjab and the North-West Frontier Province, (*d*) Bombay and Sind, and (*e*) Central India, to be established.

(7) An Advisory Committee to determine the policy of the Botanical Survey, allocate the exploration grant and select personnel for the purpose to be constituted.

Recommendations of this non-official Committee differ from the recommendations of Col. Gage's Committee in enlisting the co-operation of Indian Universities for the purposes of Botanical Survey.

Dr K. P. Biswas, the present Superintendent of the Royal Botanic Garden, discussed at length the future of the Botanical Survey, in his Presidential address to the Botany Section of the Indian Science Congress in 1943.

In a paper entitled "Present Position of Botanical Research in India", the re-organization of the Botanical Survey of India was also discussed by Prof. S. P. Agharkar, at the symposium on "Post-War Organization of Scientific Research in India" held under the auspices of the National Institute of Sciences of India in 1943.

Prof. A. V. Hill who was recently invited by the Government of India in 1944, to report on the organization of Scientific and Industrial Research as part of the Indian post-war reconstruction plan and its co-ordination with corresponding activities in Britain, in his report entitled "*Scientific Research in India*", states that as the great natural resources of India were still inadequately known, the Botanical Survey should be restored and expanded. He says,

"In deciding on the future of the Botanical Survey, that of the Royal Botanic Garden at Sibpur, Calcutta, with the great herbarium there (which is really the national herbarium of India) should be considered too. Both of these latter have been maintained hitherto by the Government of Bengal. It would be natural to associate them, by arrangement between the Government of Bengal and the Central Government, with the Botanical Survey. The Botanical Survey, restored and re-invigorated, should be able to play an essential part in long range plans for agricultural development."

It is hoped that the Government of India would now give their careful consideration to the reorganization of this important survey on the lines suggested by the Indian Science Congress Committee in 1938 and subsequently by Dr K. P. Biswas and Prof. S. P. Agharkar without further delay, and we feel that the Government of India should accept and give

effect to the following recommendations at an early date.

(1) The post of the Director, Botanical Survey of India, should be revived.

(2) The proposed setting up of the Advisory Board, as recommended by the Indian Science Congress, to be given effect to.

(3) The Government of India should take up the Sibpur Herbarium and Garden with its staff as the "National Herbarium for India".

(4) The personnel of the Survey to be expanded so as to include specialists to deal adequately with various branches of botany and the garden so organized as to render the study of experimental taxonomy possible.

(5) The constitution of "National Parks", as proposed by the Royal Asiatic Society of Bengal, in connection with a programme of cultural reconstruction of India.

The Universities in India are now producing promising young botanists and there would be no dearth of suitable personnel if opportunities are offered to them.

APPENDIX

The Botanical Survey of India

The Botanical Survey of India was constituted by the Secretary of State for India in 1889 at the instance of the late Sir W. T. Thiselton Dyer, Director of the Kew Gardens, and Sir George King, Superintendent of the Royal Botanic Garden, Sibpur in order to bring the various provincial botanical departments into communication with one another. There were four such provincial survey departments :-

(1) The Royal Botanic Garden, Sibpur (founded in 1787 as East India Company's garden and now under the control of Bengal Government).

(2) The Government Botanists' Department, Madras (Herbarium transferred to Agricultural College, Coimbatore in 1910).

(3) The Botany Department for Western India which was attached to the College of Science, Poona. (Herbarium destroyed by fire in 1902 and replaced by Dr T. Cooke's private collections. Now located in Agricultural College, Poona).

(4) The Botany Department of Northern India at Saharanpur (Herbarium transferred to the Forest Research Institute, Dehra Dun in 1909).

The last three of these provincial departments have now practically ceased to exist

Sir George King became the first *Ex-officio* director of the Botanical Survey thus constituted with its headquarters at Royal Botanic Garden, Sibpur. He was succeeded by Sir David Prain (1897-1905) ; Lt.-Col. A. T. Gage (1906-1923) and Mr. C. C. Calder (1923-39).

These officers held the substantive appointment of Superintendent, Royal Botanic Garden, Sibpur, under the Bengal Government and also held charge of the Botanical Survey, as its Director and of the cinchona plantations of the Government of India. Sir George realized the importance of the enormous vegetable wealth of this vast sub-continent. He felt the need of exploring the rich and varied terrestrial, marine and fresh water flora of India and undertook in right earnest the task of surveying the vegetable resources of the country on proper lines.

In 1905, Sir J. D. Hooker, G.C.S.I., pressed for an organized effort towards botanical exploration of the unknown areas of India and emphasized the importance of preparing provincial floras. Suggestions regarding the Botanical Survey were also made by the Royal Society of London, at about this time, to the Under-Secretary of State for India.

During the regime of Sir David Prain (1897-1906), some enlargement of the department was effected with the result that some of the important parts of the country were surveyed and some valuable work regarding economic plants was done at the garden. There was at this time an exploration grant of Rs. 5,000/- per annum provided by the Government of India.

It appears, however, that there was steady decline in the activities of the Survey under Col. Gage, which may partly be accounted for by the period of World War I and its aftermath, and partly by the increase in the administrative work regarding Cinchona operations. Similar difficulties, coupled with retrenchment, were probably responsible for a continuation of the period of diminishing scientific work under Mr Calder. Since 1939, when Mr Calder retired, the Department has been without a Director and his work has been distributed among three officers.

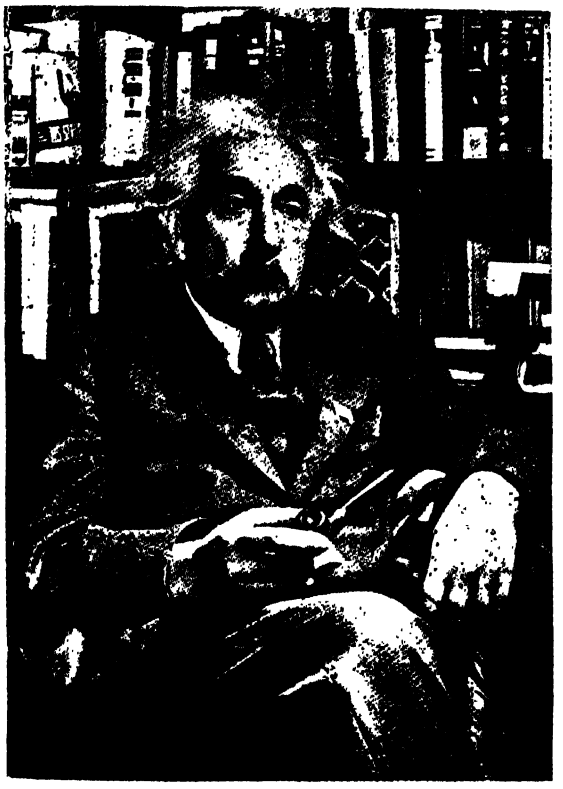
The present activities of the Botanical Survey mostly consist in continuing the work of supplying information and replying to routine enquiries with the help of one Curator (in charge of the industrial section, Indian Museum) and one systematic assistant (posted at the Royal Botanic Garden, Sibpur). The staff of the Royal Botanic Garden, Sibpur (under the Bengal Government) is continuing the work of identification and description of new species discovered during the course of their work with the help of its Superintendent and the Curator of the Herbarium.

THE STORY OF THE 'ATOMIC BOMB'

M. N. SAHA and B. D. NAG CHAUDHURI

IN relating the story of the 'Atomic Bomb' one has to narrate almost the whole story of the progress of physics within the last fifty years.

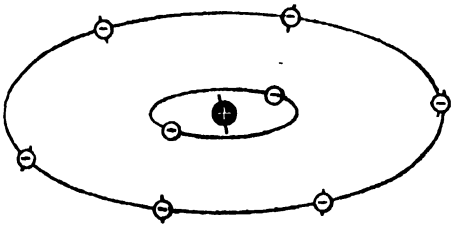
We may make a convenient start with a mathematical theorem of revolutionary nature given by Einstein in 1905. The theorem stated the equivalence of mass with energy. It followed from the Principle of Relativity and was regarded with scepticism for some time, till the cumulative experience of laboratory work compelled its acceptance.



ALBERT EINSTEIN

In mathematical language, the relation is written as $E=mc^2$ where c is the velocity of light, E is energy, m is mass. Let us explain this for the lay reader. We all know mass which is measured in grammes and energy may be expressed in ergs, calories or kilocalories, which are all related. According to Einstein's formula, one gm. of matter is equivalent to 9×10^{20} ergs, for the velocity of light has the tremendously large value of 3×10^{10} cm/sec. This energy is equal to $2{\cdot}1\times10^{13}$ calories, or $2{\cdot}1\times10^{10}$ kilocalories and is obtained by burning 2,500 tons of coal. Just fancy somebody talking that a small cube of coal each side measuring $\frac{1}{2}$ of an inch contains as much energy as can be obtained by burning 5 train loads of coal. The deduction looked quite fantastic, but the logic of Einstein's mathematics was inexorable and scientists looked for phenomena where the relation has its application.

The first of these came from the precise measurement of the weight of atoms. At this time it gradually emerged that the atom consisted of two essentially different parts: the nucleus which consisted of a core containing most of the mass and carrying a positive charge. This is surrounded by electrons arranged



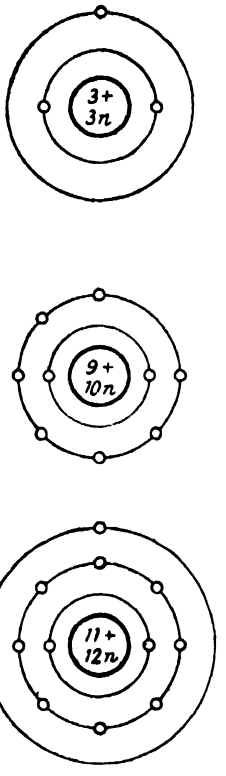
Bohr Atom

in orbits (*vide* fig.). For our theme, the electrons are of no use, and we fix our attention on the nucleus only.

Let us illustrate our point by taking the case of the helium nucleus. The mass and charge of the nuclei are too small to be conveniently measured in the usual units, so for our purpose the proton mass and the proton charge will be used as units. The helium nucleus has got the mass 4 and charge 2. It is now proved that the nucleus itself is composed of more fundamental units. These fundamental units are now known to be the proton which is the nucleus of hydrogen and is easily obtained, and the neutron, which is just a little heavier than the proton. The latter is uncharged and is more difficult to obtain.* The helium nucleus is composed of 2 protons and 2 neutrons. One should expect that the mass of the helium nucleus should be equal to the sum of the masses of its constituents, but accurate measurements show that it is somewhat less in weight: in exact measure by ·027 mass-units. Where has this mass disappeared? It was suggested that when 2 protons and 2 neutrons combine to form the helium nucleus, a large amount of energy is set free just as when carbon burns in oxygen and carbon dioxide gas is formed, a certain amount of energy is set free. But

* The Neutron was discovered only in 1932. A convenient source is a Beryllium plate over which some radium has been placed.

there is a tremendous difference in degree. One gram of carbon gives us 8 kilocalories on complete combustion to CO_2 but when 2 gms. of proton and 2 gms. of neutron combine to form 4 gms. of helium nucleus, the amount of energy evolved is enormous and can be easily calculated from an application of Einstein's principle. It is 640 million kilocalories or 160 million

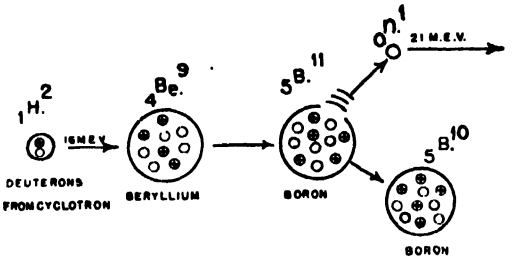


Model of Nuclei formed from Neutrons and Protons
[*Top*: Lithium^6, *Centre*: Fluorine^{19}, *Bottom*: Sodium^{23}]

kilocalories per gm. Mass for mass, the energy evolved is nearly 20 million times larger than that obtained by the burning of coal which is the basis of most of our power technique. This feature of large energy formation is shown by almost all the nuclei of atoms, which have all less mass than these constituent neutrons and protons.

Artificial Nuclear Reactions

Though we are talking of the formation of atomic nuclei from its elementary constituents, the proton and the neutron, nobody was able to effect an artificial nuclear reaction until 1919. It was supposed in a rather vague way that the elementary particles come together in the interior of stars and thus contribute to the maintenance of the fire of stars for billions of years. The first artificial nuclear reaction was performed in the laboratory by Lord Rutherford in 1919 when he bombarded nitrogen by a beam of alpha-particles and obtained an isotope of oxygen (17) and a proton. Lord Rutherford verified in this reaction that the energy relations are satisfied by making use of Einstein's principle of equivalence of mass and energy.



Diagrammatic sketch of Nuclear Reaction
[$_4Be^9 + _1H^2 \longrightarrow _5B^{11} + n^1_0$]

Nuclear reactions are not very easy to perform because if we want to bring two nuclei together, they must be given very high energies. Also, since the size of the nucleus is about 10^5 times smaller than that of the atom, most of the particles fail to hit the nuclei. Within the last fifteen years machines for producing large numbers of high energy particles have been invented and used to produce hundreds of nuclear reactions and new types of nuclei. But none of these reactions are suitable for tapping the nuclear energy for practical purposes.

Uranium Fission

The particular series of works which yielded a possible method for the tapping of nuclear energy was started by Fermi, the most celebrated Italian physicist of modern times. In 1938, Fermi was awarded the Nobel Prize for his discoveries, went to Stockholm to receive it, but instead of returning to Italy, ran away to the U. S. A. where he was given an asylum in the Columbia University, New York. Before Fermi, only beams of proton and alpha-particles (helium nucleus) had been used for nuclear bombardment, but Fermi showed that the 'neutron' was a far better agent for this purpose, and he was able to perform hundreds of nuclear reactions with it, for which the Nobel award was made to him. Then his thoughts ran in a new direction. He tried to use the new technique for the manufacture of entirely new elements.

The total number of elements so far known is 92, uranium being number 92nd. It has always been a puzzle why elements beyond number 92 are not found in nature. Has the number 92 any magical significance as was ascribed to the number seven by the mystery loving ancients? Fermi thought of submitting this query to an experimental test by smuggling a neutron into the nucleus of uranium.

He found several new products, which could be separated by chemical methods from parent uranium. He thought these elements were elements 93 to 96—*transuranic* elements. These elements are not known in nature but from Mendeleev's periodic classification, we can make plausible prediction about their chemical properties. Fermi thought that the nucleus 239 formed by the entry of a neutron into the U-nucleus was shortlived, emitted an electron, had its charge increased by one and became 93. This process goes on till we obtain element 96 which was supposed to have properties similar to platinum and to which the name ekaplatinum had been given by Mendeleev.

But these deductions excited a certain amount of distrust. There was no doubt that a large number of new products was formed, but were they really transuranic elements? In fact there



OTTO HAHN

[Otto Hahn, the discoverer of uranium fission which ultimately led to Atomic Bomb, was born on the 8th March, 1879. He started life as a young organic chemist in an industrial concern, but gradually transformed himself into a radioactive chemist. He had worked with the English chemists, Ramsay, Soddy and Rurtherford and when elected to the Membership of the Prussian Academy of Sciences, he spoke of his good luck in being able to work with such great names in the chemistry of radioactive substances. But Planck, President of the Academy, replied, "*In science we very often find work without luck, but never luck without work.*" The great work on uranium fission which Hahn brought to light from a series of obscure and puzzling observations could only be done by one with the training of a great analytical chemist, and was the result of a solid amount of work. From 1912, he was Director of the radioactive section, of the Kaiser Wilhelm Institute at Berlin-Dahlem, and was the discoverer of Mesothorium and Radiothorium.]

were too many of them. At this stage the investigation was taken up by Hahn and Meitner in the Kaiser Wilhelm Institute in Berlin-Dahlem and I. Curie and Savitch in Radium Institute in Paris. They found that the number of new products was much larger. In fact, Hahn and Meitner counted no less than 9. Curie and Savitch found a new product which they said was similar to the radioactive element actinum No. 89 but was much closer to the known element No. 57 called lanthalum. Had Curie* and Savitch followed this matter further they would have discovered the phenomenon, but somehow they stopped here. In the meantime Hahn at Berlin had been hard at work with his pupil Strassemann and proved definitely that one of the products which was supposed to be an isotope of radium was not radium at all, but barium which is element No. 56. This confusion is to be ascribed to the fact that radium and barium are almost identical in their chemical properties and none but a very experienced chemist of the type of Dr Hahn could have succeeded in identifying definitely the very minute amount of barium produced in the experiment and recognising it clearly as distinct from radium. This discovery gave them the clue to the mystery and led to very startling results. The element uranium is No. 92 and the element barium which is formed from it after it has been bombarded with neutron is number 56. How can it be possible for barium to be produced out of uranium at all? The explanation was almost forced on the investigators that as a result of the impact of the neutron, the nucleus breaks up into two halves, one having the atomic number 56 and the other having the atomic number 36 or 37. Further works by Hahn and Strassemann and others showed that U can break up into two fragments in many other ways. The fission results are illustrated in the figure (on the next page) reproduced from an article in SCIENCE AND CULTURE published four years earlier.

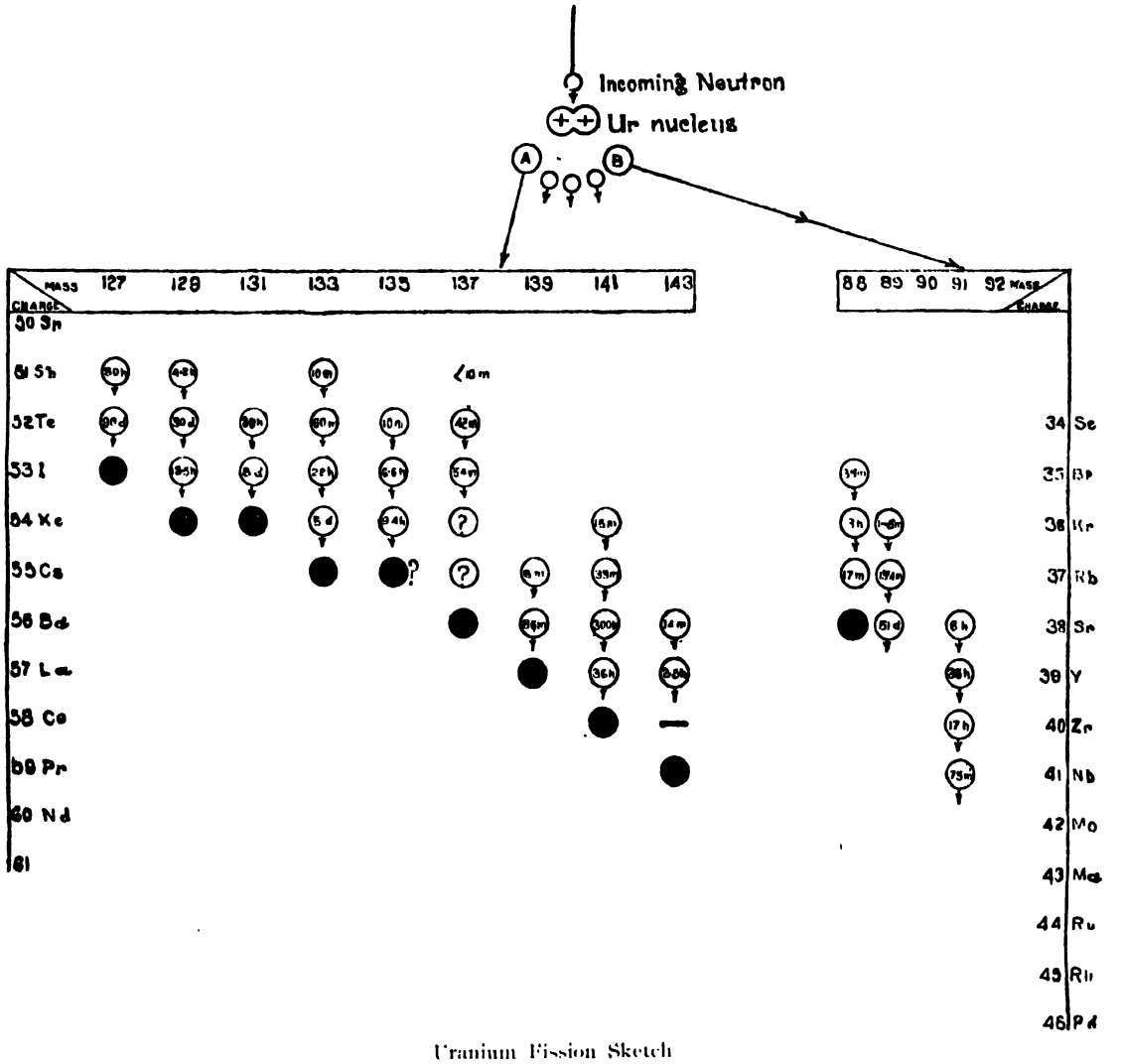
MECHANISM OF URANIUM FISSION

It was very soon found that this fission of uranium nucleus is not due to the force of impact of the neutron, for even neutrons slowed down by paraffin to an energy of a few volts show this effect. Further, no other element excepting uranium and its next heaviest neighbours protoactinium (No. 91) and thorium (No. 90) show this effect. There is, therefore, some latent instability in the nucleus of uranium itself; the introduction of a neutron acts as a trigger like the lighting of a match box in a powder magazine. This point of view is further corroborated by a comparison of the mass of U to those of the fragments in which it is likely to break. The

* Two contemporary physicists of reputation ascribe the discovery of uranium fission to I. Curie. This is a mistake. They just missed it.

U-nucleus is somewhat heavier and is thus endothermic like certain explosives. Bohr compares the nucleus of uranium to a drop of liquid which, when a high charge is given to it, is somewhat deformed from its spherical shape, but is kept together by surface forces and can be ultimately broken up if the deformation is large. When the neutron enters the U-nucleus the vibrations set up in the body of the nucleus are so violent that it breaks up into two, may be in more fragments. Bohr further discovered one very important point. Uranium as found in Nature consists of two isotopes, U^{238} and U^{235}. This last is also known as actino-uranium and occurs in very small quantity, only one part in 140. Bohr showed that it is really this rarer variety of uranium, U^{235} which is the active agent. In fact mass for mass its activity is nearly 1000 times more than that of its bigger brother U^{238}.

Energetics of fission.—It can be shown from mass relations that when the two fragments of uranium fly away from each other, they do so with tremendous energy. In fact the energy carried by these particles has been experimentally measured and found to reach the high value of 200 million electron volts. Converted into familiar energy units, it means that when 235 gms. of uranium is broken up in this fashion the energy produced is $4{\cdot}9 \times 10^{9}$ kilo calories, that is to say, when one gm. of uranium is completely fissioned it will give us $1{\cdot}9 \times 10^{7}$ kilo calories. The process really gives thousand times less energy than that from total conversion of mass, but still it is million times more energy yielding, mass for mass, than a chemical reaction. This energy is obtained by burning 2 tons or 2 million grammes of coal. This shows that the fission process, if it could be actually realized in practice, would usher a new

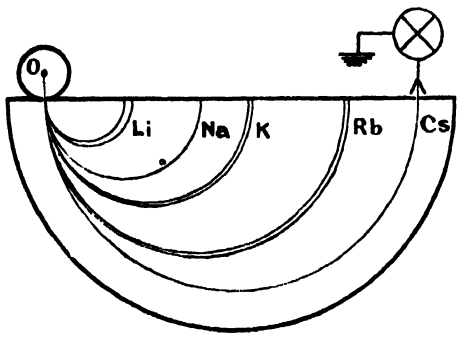


Uranium Fission Sketch

age in the science of energetics, in power technology and in explosives.

What stands in the way of these ideas being put to practice? The real difficulty is that the efficiency factor is extremely low. If we shoot a billion neutrons into a mass of uranium, hardly one will hit the nucleus. So what we gain in the individual process is lost in the inefficiency of the process. Can we improve the efficiency?

The first step, it is obvious, is to get a good supply of U^{235}, for if we can use this exclusively we could increase the efficiency factor by about 200 times. But this is not an easy task. U^{235} has the same chemical properties as U^{238} and cannot be separated from its isotope by chemical methods. We must use physical methods of which several exist now. In the preparation of the atomic bomb a large quantity of U^{235} must have been produced as a first step, although it is not clear which method has been used. Isotope separation is really a heart-breaking job. Aston in 1906 started separating the isotopes of neon in 1906, and worked for 10 years without any result. One of the methods that has been successfully used is the mass-spectrograph. The particles are given a certain charge and are deflected in the magnetic field. Particles of different mass will then separate and collect at different places.



Separation of masses by Mas of Spectroscope

[The two isotopes of lithium of weights 6 and 7 are separated in the magnetic field as indicated by the two semicircular lines close together marked Li. The semicircle of smaller diameter represents the path of lithium 6, the larger circle the isotope 7.]

Just before the outbreak of the war, another German physicist Clusius, developed a very powerful method of separation of isotopes which can be used for gases and substances which can be used in the form of solutions. It is known as the thermal diffusion method. By this method, considerable quantities of Cl^{35} have been separated from Cl^{37} in a few hours, a task which the earlier workers could not accomplish in 10 years. The method requires long columns of glass, plenty of refrigerating material, etc. etc. Large quantities of U^{235} must have been produced by one or both of these methods.

Copious Supply of Neutrons

The next step is the production of sufficient quantity of neutrons for starting U-fission. In the laboratories the neutron is produced either by the cyclotron or high voltage apparatus or by the contact of radium with beryllium or other light elements.

Such methods cannot evidently be used in the atomic bomb. One cannot attach a high voltage apparatus or a cyclotron to a bomb and radium would be too expensive even for the dollar-land. In the bomb, use is probably made of the deuteron-deuteron reaction. Let us see what it is.

'Deuteron' or heavy hydrogen is the isotope of hydrogen; while ordinary hydrogen has the weight one, the deuteron has the weight two; its nucleus is twice as heavy as the proton. It occurs in the proportion of 1 : 8000 in all sources of hydrogen and its supply is apparently unlimited. Even 15 years ago its existence was unsuspected, when Urey, an American physicist, was led to formulate its existence from some obscure data in the density determinations of hydrogen and could actually separate it in quantity from water subjected to repeated electrolysis. This is the method used at the present time for obtaining heavy water, which consists of water with heavy hydrogen in place of hydrogen. Once heavy water is obtained, we can obtain any amount of deuteron by electrolysis.

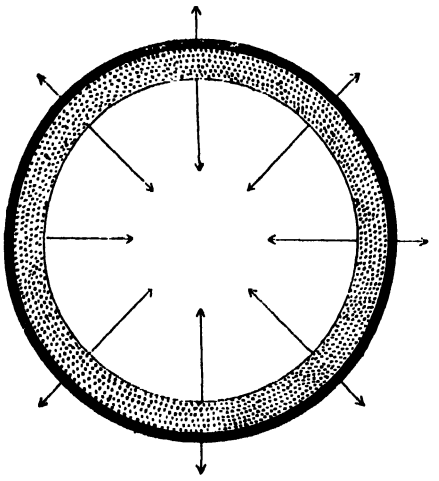
The nucleus of heavy hydrogen or the *deuterium* is a compound of the proton and neutron; in fact it is the simplest compound known of the two fundamental nuclear particles. The deuteron nucleus is very useful for nuclear reactions. It passes almost as easily into nuclei as neutrons and has been used to produce a number of novel reactions. The deuteron has also the property of producing neutrons when it impinges at moderately high speed on other deuterons. As was first shown by Lord Rutherford, the nuclear reaction can be represented as

$$D + D = He^3 + n.$$

Further this reaction starts at comparatively low acceleration of the deuterons. In fact an acceleration of about 20,000 volts is sufficient to produce this reaction. This is equivalent to a velocity of 1000 kilometres per second. This is a small velocity for nuclear reactions, although moderately high compared to velocities that may be obtained in a discharge tube with a high voltage transformer.

It will be interesting to examine the possibilities for obtaining the high velocity deuterons for producing neutrons in the small weight and volume that

make up the atom bomb. A chemical explosion generates a large temperature and pressure. The velocities of the flying gas particles due to the pressure as well as the temperature are never more than 90 or 100 kilometres per second under the most favourable conditions. The deuterium of course will be introduced in the explosive by replacing chemically hydrogen in the explosive charge by deuterium. Using a hollow charge explosion the relative velocity of the gas particles moving towards the centre from opposite directions will be twice as much as illustrated in the figure. If the velocity of the flying gas particles flying towards the centre could be increased about 5 times to around 500 km sec., the deuterium particles in the flying gas could collide with each other to produce a burst of neutrons on the detonation of the explosive. This of course is a plausible guess, as the exact technique for producing such velocities by explosive means is not known. The second possibility of generating deuterons at high velocity by a high voltage discharge is entirely feasible and is the cheapest method of producing neutrons in the laboratory. The difficulty of including inside the bomb a high voltage transformer or induction coil, a source of electric power, a properly designed discharge tube and starting devices for these into the small space and weight of a bomb seem to argue against the possibility of such devices being used in the bomb. However, since the exact mechanism of producing the neutrons in the bomb is not known, the remote possibility of using such devices should not be entirely ignored.



Principle of the hollow charge explosion

Let us now examine how a burst of neutrons produced initially by any of the methods outlined above could release the latent energy of fission of a greater part of the uranium^{235} in a bomb. The number of atoms of uranium that may be fissioned by a certain number of neutrons depends on what is termed the cross-section of fission, *i.e.*, the chance of producing a fission by a single neutron incident on uranium. The number of fissions n per second equals the product of this cross-section, the number of neutrons incident per second and the number of uranium atoms in the volume on which the neutrons are incident. Mathematically this is expressed as $n = Nn'\sigma$ where n is the number of fissions per second, σ is the cross-section and n the number of neutrons incident per second. N is the number of uranium atoms in the value. σ for the slow neutrons on U^{235} is nearly 100 times greater than the fast neutrons and is somewhat greater than 10^{-22} cm^2 If we take a gramme of U^{235}, the number of fissions, assuming a million neutrons in a second are incident on the uranium, equals

$$2 \times 10^{-22} \times 2{\cdot}4 \times 10^{21} \times 10^6 = 480{,}000.$$

During each fission, in the process of the two parts of the atomic nuclei separating, about 4 neutrons are given up by the nucleus. This implies that $1{\cdot}9 \times 10^6$ neutrons are generated by the million neutrons inducing fission. These neutrons in turn can produce fission in the remaining uranium. It may be noticed that with a million neutrons per second to start with, we can produce almost twice the number of neutrons per second as we originally used in the first step. These in turn will cause further fission of uranium and break up a further number of uranium nuclei. Each time twice the number of neutrons as the previous fission proceeds will be generated so that it will be a chain process and will only stop when the number of uranium atoms has decreased to such an extent that the number of neutrons generated is smaller than the number of neutrons causing fission.

In our present example this will happen after more than 90% of the uranium has been fissioned, so that the energy of about 9/10ths gramme of uranium may be obtained in such a reaction starting with one gramme of uranium. If we started out with a bomb containing 100 grammes of uranium^{235} and weighing 500 pounds, the energy released will be roughly 100 times as much which, from our previous data, is about $1{\cdot}0 \times 10^9$ kilocalories. Seven hundred gms. of U^{235} in the bomb would give us the same energy as was produced in the great explosion which took place at Oppau in Germany in 1921, where nine million pounds of ammonium nitrate stacked in the open exploded, killing 1000 and wounding 1500, and the zone of serious damage extended to a four mile radius. The recent explosion in the Bombay Harbour where 2000 tons of T.N.T., exploded, was on the same scale. Just fancy what would have happened to Bombay if the shipload of T.N.T. instead of exploding 1 mile from the harbour, exploded in the centre of the city. That would give one the terrible ordeals to which the people of Hiroshima and Nagasaki were subjected

The energy of the explosion may be assumed to be dissipated uniformly through the 500 pounds of the bomb materials, enabling us to calculate the temperature reached in the bursting of the bomb: we obtain it by dividing the total energy of uranium fission in calories by the mass of the bomb in grammes and making rough guess as to the average specific heat of the material of the bomb. The temperature comes out between ten million and a hundred million degrees Centigrade. This calculation does not take into account the losses of heat due to radiation, ionisation and mechanical effects that will surely take up a part of the energy of fission. The temperature is well in the order that exists within the interior of stars and one may well imagine what the effect of this temperature will be for miles around. This makes it possible for the first time to produce and find out on the Earth the effects of such high temperatures. It may help us to understand in the future the mechanisms that go on in the interior of the stars.

We might well consider at this stage the cost of making such bombs. The main item of course is the separation of uranium^{235}. A rough calculation on the basis of the mass-spectrographic method of separation is possible. Nier and Dunning in 1940 separated $1{\cdot}3 \times 10^{-9}$ grammes of Uranium^{235} by mass-spectrographic method in 10 hours and used approximately ·5 K.W.H energy (·5 units) in the process. The efficiency must have been considerably improved since those days. Assuming an over all improvement of 3 times due to technical developments and improved efficiency, it will still require 10^8 kilowat-hours of energy to separate one gramme of U^{235}. Even at 1 cent a unit this will amount to a million dollars per gramme of uranium^{235}.

To this we must add the cost of obtaining and separating the element uranium which is quite rare and that of manufacturing proper alloys and materials to produce the preliminary explosion which will yield the neutrons.

According to these calculations, the whole amount of electrical energy, now produced in India in the year is barely sufficient to produce 100 gms of U^{235}, and even the U.S.A. cannot manufacture material for more than 50 such bombs per year. But it is quite possible that more efficient and economical apparatus for separation have since been developed, *e.g.* by the thermal diffusion of uranium tetrabromide. It is obvious that the production of this terrible weapon of destruction under the present state of our knowledge is beyond the capacity of individuals or even of small States. Only large States like the U.S.A., England, or Soviet Russia have the capacity to undertake their manufacture.

Strangely enough both the basic discoveries of uranium fission and of thermal diffusion method of separation of U^{235}, which brought the dreams of utilization of atomic energy within the range of practicability, were made in Germany, and in the early part of 1939. The Germans were also the earliest to take up seriously the problems of practical utilization of these discoveries. Apparently this was the secret weapon which Hitler was threatening to use against his enemies when his end came. But why were not the Germans able to perfect the 'Bomb' before their collapse?

It may not be realized by the public that between the first suggestion regarding the utilization of atomic energy and the actual use of the atomic bomb, there must have intervened concerted team work by hundreds of nuclear physicists and chemists, including some of the most eminent living men on these subjects, and also geologists, engineers and technicians. They must have used huge plants to generate electrical energy required for the separation of U^{235}, set up factories for manufacture of heavy hydrogen and using it in place of hydrogen in the chemical explosives, and carried out researches on the manufacture of special alloys and their manufacture. The money spent was, we are told, four billion dollars, which is two years' revenue of the Government of India and the Provincial Governments. It is not an unlikely figure, considering the magnitude of the effort made.

But apparently even in spite of such effects, the bomb could not be made a practical proposition before the collapse of Germany! It was probably after the collapse that the knowledge of scientists on both sides had to be utilized in a common pool before success could be achieved. But this is a mere guess, and if the story be ever told, it will prove terribly fascinating!

The failure of Germans, in spite of their initial start, may be in part due to the expulsion of some of their best scientists on racial grounds, and their failure to enlist the services of scientists of occupied countries.

A few words regarding the basic element uranium of which these bombs are made may not be entirely out of place. Uranium is the heaviest of elements, and its radioactive properties have been well-known since the discovery of radioactivity in the closing years of the last century. It appears to play quite a prominent part in the heat economy of the Earth, which is assumed to have been cooling through at least 2000 million years after its separation from the Sun. The rate of cooling is rather too slow and indicates that the heat lost by radiation is largely compensated by a source of heat within the Earth. With the discovery of radioactivity, the source has been identified with the radioactive matter in the Earth. On this basis, Holmes and Paneth estimate that there are about 8×10^8 tons of uranium in the Earth. If there were more, they conclude, the Earth would have burst some day. On this basis,

the surface crust of the Earth up to a mile in depth should contain about 3×10^4 tons of this material. Extensive surface assays of the radioactive content of the Earth's crust indicate a much larger figure for the radioactive content of the surface crusts. Some assays indicate as much as ten times the figure. Assuming a more modest figure of 10^5 tons, the total U^{235} present on the Earth's surface is about 780 tons and the radium content in equilibrium with U^{238} is about 15,000 grammes. The interesting point that emerges is that the crustal rocks contain a great deal of more uranium than the interior magma and that perhaps no very extensive sources of uranium minerals remain to be discovered. The most extensive deposits known occur in the region of the Great Bear Lake in Canada, with deposits in Katanga region of Belgian Congo and Joachimstal in Czecho-Slovakia following in the order mentioned. Russians claim discoveries of rich deposits in the Urals and in the Khibin peninsula (Murmansk). Smaller deposits occur almost all over the world. Norway, Cornwall in England, the U.S.A., China and India have all reported the occurrence of these minerals. The extent of the deposits in India have not been well investigated. thorium occurs in larger proportion in India and though this can be fissioned, the efficiency is too low, and this cannot take the place of uranium as is claimed by some enthusiastic Travancorians. All uranium deposits are potential sources of U^{235} and undoubtedly greater interest will now be displayed in their occurrence, extent and other possibilities specially since the limited nature of these resources will make it imperative for nations to try to own as much of it as possible.

The effect of the atomic bomb burst over a city will be to produce instantaneously a mass of ionised vapour with a pressure of 10^9 atmospheres and at a temperature of nearly 100 million degrees. It is as if a chunk from the interior of stars is just thrown on the earth. The effect of the blast will be to reduce all buildings within a short distance to atoms, and then burn everything within a few kilometers. Whatever living beings, men, animals or plants, who happen to escape probably at the outer periphery of the central zone, will have a further terrible ordeal to face.

For one of the after effects of large scale fission of uranium is the generation of large amount of temporary radioactivity; for the immediate fission-products are all radioactive. Most of it, of course, will decay quickly but there are fission-products whose activity decays more slowly and it is possible that even days after an explosion of 100 grammes of U^{235}, which in itself is sufficient to destroy completely a city of a million inhabitants, there will be a large amount of radioactivity still contaminating the area where the explosion took place. This radioactivity is likely to have very harmful effects on all living matter, men, animals and plants, exposed to it. The usual effects at much lower intensity of radioactivity is known. In most cases the subject is doomed to a slow death depending on the amount of exposure, as well as deep seated change in the blood of men and animals. It is possible that many people may be so affected. The long range effect of these strong radiations on those plants and animals that survive is unpredictable but biologists think that some of the harmful effects may become apparent years later or even in the second or third generations. These are really devastating consequences on which it is well to ponder. Recent newspaper reports confirm that the effects of radioactivity have played havoc with the population in the two cities bombed with these atom bombs.

It is indeed a very great pity that science has lent itself to the evolution of destructive weapons that threaten mankind with a horrible doom (?) Is it not time for scientists to take stock of the situation and to think about effective control of the tremendous forces that he has learnt to use.

But is the 'Uranium Bomb' the limit of "*Schrechlichkeit*"? No, for in this, we convert only a small amount of mass barely 1 in 1000, to energy. More efficient processes are not ruled out. In fact, some physicists are of opinion (though others do not agree with that view) that the mysterious cosmic rays are due to the total conversion of matter into energy, taking place somewhere in space, probably in some *supernova* outburst. The possibility of carrying out experiments on the total conversion of mass into energy in the laboratory in the near future should not be lightly dismissed particularly in view of the rapidity with which the 'Atomic Bomb' has been evolved. But let us hope the world will be spared from any further atomic bomb, or superatomic bomb "Schrechlichkeit".

[Amongst the comments on the atom bomb the extracts from the letter published in "The Times" by the famous scientist, Sir Henry Dale, the President of the Royal Society, who is on the new Anderson Committee may be quoted: "While scientists loyally kept the secret of the atom bomb while war was in progress, they, once the war with Japan is finished, will all wish to be done with the secret for ever. We have tolerated much and would tolerate anything to ensure victory for freedom, but when victory has been won we shall want the freedom".

Dr Norman Campbell asked whether "it was really necessary to conceal so carefully the fact that nuclear fission on which the atomic bomb depends was discovered in Germany".

American papers just received say that the explosive power of the atomic bomb that was thrown over Hiroshima was equivalent to 20,000 tons of T.N.T. The preliminary experiment carried out on a steel tower in Arizona showed that the explosion was so violent that the city of Albuquerque, 120 miles away was illuminated as in broad day light. The experiments were carried out in three cities, Oak Ridge, 10 miles west of Knox Ville, Pascoin, Washington State, and Los Alamos near Santa Fe, New Mexico.—Ed. *Sc & Cul.*]

INDUSTRIAL RESEARCH

THE Industrial Research Planning Committee constituted early in 1944, with Sir R. K. Sanmukham Chetty as its Chairman, to make a survey of the existing facilities for scientific and industrial research in India and report on necessary measures of co-ordination, control, direction and development of such research, has just submitted its report. The Committee issued questionaires to various universities, research institutions and Government departments interested in industrial research and also to chambers of commerce and like industrial associations, visited several universities and research institutes, and contacted eminent scientists and industrialists of many of the leading and representative centres of scientific and industrial research. The general impression of the Committee is that 'with a few notable exceptions, Industry in India is not research minded'. Equipped laboratories and maintenance of regular research are mostly unknown in Indian industrial organization.

The Committee has recommended the establishment, by the Government of India, of a central research organization to be called the *National Research Council* which should come under the Department of Planning and Development, with the Hon'ble Member as the 'ex-officio' President. It is recommended that the Government should provide a block grant of Rs. 6 crores to enable the Council to discharge its functions which include the following :-

(1) To organize and maintain national laboratories.
(2) To establish and maintain specialized research institutes.
(3) To stimulate pure and applied research in universities by grants-in-aid and by the institution of scholarships and fellowships.
(4) To provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad.
(5) To stimulate and encourage research activities by Industry.
(6) To co-ordinate research activities of all the existing research institutes and departments of Government and undertake planning of research programmes on a comprehensive basis.
(7) To function as a National Trust for Patents.
(8) To set up a Board of Standards and Specifications.
(9) To function as Clearing House, encourage deserving scientific and technical societies and foster the growth of new ones in appropriate lines.

The Council should consist of 60 members, of whom 20 members (all scientists) would be elected by all the universities and recognized scientific associations and academies, 15 members by recognized chambers of commerce and association of manufacturers, and 5 members by recognized trade unions and other labour organizations. The Government would nominate 20 members, of whom not more than 8 may be officials. The Council will be responsible for direction and control of scientific and industrial research. The immediate task of the Council, as recommended, will be to make and carry out a five-year plan of research organization, consisting of (1) the building and equipping of a National Chemical and a National Physical Laboratory, (2) the building and equipping of certain specialized research institutes totalling nine,* (3) providing grants-in-aid to universities, and (4) training research personnel by the award of scholarships tenable in India and abroad.

The two National Laboratories are recommended to be established at an estimated cost of Rs. 40 lakhs each. The establishment of all the research laboratories would involve a total expenditure of about Rs. 2·5 crores. The importance of universities as the foundation of all research has been recognized, and it is recommended that a sum of about Rs. 2 crores should be set apart for giving grants-in-aid. The first five-year plan should include the provision to train about 700 research workers at an estimated total expenditure of about Rs. 50 lakhs.

The Council, with its 60 members, is too unweildy a body to undertake executive and administrative functions which are, therefore, proposed to be invested in a small executive body to be called the *Research Board*. The Board would consist of three full time members who should be scientists of highest ability and would be assisted by a full time secretary with an efficient secretariat. The Board will be the principal executive organ acting under the general direction of the Council.

The Committee recommends the creation of a *National Trust for Patents* under the Council for the purpose of holding and exploiting all patents arising out of research financed by the Government. Similarly, the formation of a *Board of Standards* has been recommended. The function of the Board of Standards will be to draw up Indian standard specifications and make necessary arrangement for allied research. It is proposed that the Test House at

* 1. Institute of Food Technology; 2. Metallurgical Institute; 3. Fuel Research Institute; 4. Glass and Silicate Research Institute; 5. Oils and Paints Institute; 6. Buildings and Roads Institute; 7. Leather and Tanning Institute; 8. Industrial Fermentation Institute; 9. Electro-Chemical Institute.

Alipur should be transferred to the control of the Council. Moreover, the constitution of three Committees, namely a *Standing Technical Committee*, a *Budget Committee* and a *Grants Committee*, has been suggested. The last Committee will advise on the allocation of grants to universities and research institutions.

The execution of the programme drawn up for the first five-years will consume the block grant of Rs. 6 crores. To enable continuity of the Council's activities thereafter, it is recommended that the Government should provide an annual grant of Rs. 1 crore to the Council and that the industry should be asked to contribute an equivalent amount. The contribution from the industry will have to be realized by the levy of statutory cess of 1/16th of one per cent on the value of industrial production.

The proposed Council will be an All-India organization, and it is recommended that similar scientific organizations for the promotion of industrial research should be set up in the Provinces as well as in the States.

We feel that the report gives a very sketchy and unsatisfactory survey of the present position of scientific and industrial research in India. The findings of the Committee are nothing new, and the views expressed by it have been again and again ventilated by such journals as the *Science and Culture*, and the *Current Science*. Moreover, the idea of a National Research Council has been borrowed without acknowledgement from a resolution passed in the annual meeting of the National Institute of Sciences held in Delhi in January 1944. The National Institute of Sciences suggested the establishment of a National Research Council* after the model of a similar Council existing in the U.S.A., but did not elaborate its precise schemes.

It was for the Chetty Committee to have given a precise scheme, but except merely expressing an intention to replace the present Council of Scientific and Industrial Research, for which it has stated no reasons, it has given practically no scheme at all. This is rather unfortunate, for India has already evolved scientific organizations doing certain amount of useful work, and no new scheme can entirely ignore them. In this respect, Prof. A. V. Hill's recommendations have been far more practical and useful than the vague generalizations of the Chetty Committee.

We note that three of the members of the Committee have been long absent from India, and apparently the Committee as a whole never met to discuss the ideas in the minds of the different members and evolve a scheme which would be useful to the country. The recommendations have, therefore, been loose, disjointed and vague. This is rather unfortunate, as the vacuum in the cranium of many public men and industrialists, who aspire to control science and scientists in this country, is likely to be filled with such staff as is contained in the report of the Chetty Committee.

* The N. R. C. in the U. S. A. is merely an active agent of the National Academy of Sciences and performs very restricted functions. The Canadian Council, on the other hand, is a very active body, has a number of research institutes under its control and co-ordinates their activities, through an executive body consisting almost wholly of scientists. The Japanese body is in close connection with the Imperial Academy of Science which practically governs it and has many research institutions under its control like the Canadian body.

FILMS FOR SCIENCE

K. V. GIRI,
INDIAN INSTITUTE OF SCIENCE, BANGALORE

IN recent years motion pictures have made great strides as a tool in scientific education and research. The value of the film in scientific and technical education is now being widely recognized in every advanced country in the world, and plans for its development are now being discussed in conjunction with other post-war developments in every country. This is the age of science and in this new environment if one is to live happily one need some knowledge of science and feeling for the scientific outlook. The introduction of films in scientific education and research deserves, therefore, careful consideration. Although the more conservative type of scientist is still sceptical in regard to the claims that are being made of it, the film of the future is destined to play an important part in scientific education and research.

Scientific work, especially the study of biological sciences, which can be made more intelligible by the proper use of the film, requires practical work on the living organism in the laboratory together with field studies of animals and plants in their natural environment. Film records of natural processes of plants and animals, of experimental demonstrations, of technical processes constitute an efficient method of putting students into close touch with the realities of their subject. Such technical and scientific film can be made so effective that they enable us to teach students without the actual presence of teacher. A typical example of such a film which was recently produced in Russia under the direction of Academician Choudokov is the one entitled "The Automobile." With the assistance of this film containing 90 reels, several

hundred thousand drivers of cars, trucks, tractors, tanks and motor cycles received instruction in driving and were fully trained.

The film has proved to be a valuable tool in the study of the dynamics of living matter. The film can be used to record in detail the behaviour of organism and other living animals at a given period of its life. Such faithful records of living pictures can be preserved and demonstrated to others at any time when to perform or repeat such experiments under the same conditions would be impossible. The film can be used as a faithful recorder of various complicated phenomena involving rapid or slow motion, such as the vibrations of strings of musical instruments, motion of bullets, germination of seedings etc. It can, therefore, be used for permanently recording the transient phenomena in all its details, thereby enabling such complicated movements to be studied and analyzed accurately.

It is interesting to know that cinemotography had its origin in biologocal curiosity. It was the desire to know wheather a galloping horse ever has all its four feet off the ground at the same time, which induced Muybridge in 1872 to devise a battery of cameras for taking pictures of the galloping horse. Threads were stretched to the shutters of twenty four cameras. The galloping horse was allowed to pass in front of the cameras and in so doing broke threads and thereby exposed the plates. Thus a rapid succession of the pictures of the galloping horse were obtained. Later Professor E. J. Marey, a well-known French investigator of motion and physiologist, attempted to solve his scientific problems with the aid of cinematography. Instead of the battery of cameras used by Muybridge, he improvised a camera with a rotating shutter producing a single negative with mutiple exposures of the object moving across the camera. He also devised a photographic gum to study birds in flight. In fact, the names of Muybridge and Marey, the physiologist, are very familiar names in the field of cinematography. In spite of these early developments in the application of cinematography to the study of scientific problems, scientists have not yet utilized its advantages to its full extent. It is only in recent years that scientists in other countries have evinced interest in the application of cinematography in scientific education and research.

Development in Other Countries

The keen interest shown by scientists in Great Britain has been responsible for starting a number of scientific film organizations. It is stated that in Great Britain there are today nearly 100 scientific film associations, while in 1938 there were only two. These associations have recently come together and constituted a single national association called the Scientific Film Association.* This Association was constituted in 1943 under the presidency of Mr Arthur Elton, with the aim of promoting national and international use of scientific films. The Association hopes to develop the film medium in every way to further the integration of science and society and believes that by the use of film the "man in the street" must become the "citizen scientist". With these objects in view the Association has devised short term and long term plans such as courses in film technique for scientists, publication of a journal, conferences, establishment of libraries etc.

The formation of this society is a sequel to the findings of the special committee known as the Scientific Film Committee† set up in 1937 by the Association of Scientific Workers, of which Sir Gowland Hopkins is the president, with the object of furthering the interests of scientific films and to encourage the production and exhibition of such films. This Committee grades scientific films into the following classes, interpretative films, educational films and research films and appraises their scientific value, and issues certificates of merit to suitable scientific films. The Committee also renders valuable advice and assistance to those who desire to produce scientific films. It also maintains a list of scientific films. Working in close collaboration with this committee is the British Film Institute,‡ the objects of which is to collect and disseminate information concerning the use of films for scientific and educational purposes. The scientific Research Panel of the Advisory Council to the British Film Institute is attempting to obtain all information regarding the extent to which films have been used by scientific research workers and other details relating to their production. In U.S.A., the Rolab Photo-Service Laboratories§ were established with the object of assisting and collaborating with others in the production of scientific films. The laboratories also train individuals in the making of scientific films.

Production Technique

One of the most important applications of motion picture to science lies in its domination of time. Motion pictures have given us an advantage over space similar to what we have derived from the use of telescopes and microscopes in respect of space. It is a tool by which we can analyze thoroughly motions which are

* The Scientific Film Association, c/o. Royal Photographic Society, 16, Princess Gate, London, S.W. 7, see also *Nature, 152*, 745, 1943.

† The Scientific Film Committee of the Association of Scientific Workers, Kelvin House, 28 Hogarth Road, London, S.W. 7.

‡ The British Film Institute, 4, Great Russel Street, London, W.C. 1.

§ The Rolab Photo-Service Laboratories, Sandy Hook, Conn., U.S.A.

too fast or too slow to be perceived with the naked eye. This can be acheved by photographing slow movements with the time lapse camera and rapid movements with high speed cine camera, thereby translating these invisible motions into perceptible motions.

Time-lapse motion pictures.—Motion pictures which are produced by exposing single frames at regular intervals of time and projecting in the usual manner constitute one of the valuable methods of studying the growth and movements of objects which take place at a considerably slow rate. Such motion pictures are known as time-lapse motion pictures. They may also be called "fast-motion" pictures because they make the object to appear to move faster than it actually did, as opposed to "slow-motion" pictures. This is used in the study of the growth of plants or cells, germination of seeds, hatching of eggs etc. The growth or movements of such objects which may require days, weeks and even months may be condensed to a few minutes on the screen thereby facilitating close analysis and study of the characteristics of growth, motion and rhythmic movements of object under investigation. This accelerated photography is the only means available for the study and analysis of slow movements.

The important requisite for time-lapse photography is a motion picture camera with device to expose one frame at a time at regular intervals. It is desirable to have an automatic method of exposing single frames at intervals which can be adjusted to suit the rate of motion of growth of object under study. When artificial lights are used it is necessary that lamps are also switched on at the exact time of exposure of each frame. Such equipment is rather costly and elaborate. The design of a simple and cheap camera which may be of interest to investigators using this technique has been described by Harris[1]. Cine-Kodak special is admirably suited for this type of work. A flexible time-lapse outfit to be used in conjunction with the camera has been designed by the Eastman Kodak Company and is described in a paper published by Fuller and Eaton[2]. A description of the automatic method of turning the lights on for the exposure and turning them off afterwards, irrespective of the interval between pictures, is also given. The equipment which has been constructed to meet the above requirements is known as the Electric Time-lapse outfit. It consists of two parts, the Electric Release Control and the Interval Timer, which are described in the paper.

High-speed motion pictures: Very fast movements can be analyzed and studied by means of high speed cine camera. The slow motion pictures which we see on the cinema screen are taken by exposing the film at a rate more than the normal number of pictures a second. When the film is projected on the screen at normal speed, the actual motion of the object is slowed down whereby every movement can be seen in detail. The ordinary movie camera takes 24 pictures a second. The ordinary high speed movie camera takes up to 3000 pictures a second. Special models of high speed cameras have now been developed, which expose 2000-4000 pictures a second. The "Kodak" super-speed cine camera exposes 2500 pictures a second moving about 70-100 miles per hour. By showing such a film at the normal speed of 16 pictures a second, time is magnified, split second action is stretched into minutes, and movements which are too fast to be perceived by the naked eye can be studied in detail. This technique is in routine use in ballistic and other researches. With the help of such high speed motion pictures, it has been possible to effect improvements in designing faster planes more powerful motors and to study the bursting of bombs, the flights of bullets, rocket prejectiles, the action of shock absorbers on guns, tanks and armoured cars. Thus high speed cine cameras have played important role in the war effort. Complicated phenomena invisible to the naked eye such as those occurring within the combustion space of an operating gasoline engine have been studied with the help of the high speed motion picture technique. For this purpose a special motion picture camera has been designed for exposing a continuous film, the image motion being synchronized by means of a number of lenses fixed in a disc mounted on the engine crankshaft. A large quartz tube mounted on the cylinder head enabled pictures of the entire combustion chamber to be taken. It is stated that the camera photographs thirty pictures of a single explosion, the rate of exposure being 5000 pictures a second. Pictures of the internal working of the gasoline engine have been taken which show the ignition spark, the spread of the flame through combustion chamber, gas movements behind the flame and various other phenomena which are impossible to see with the naked eye (Rassweiler and Withrow[3]). When this film is projected at normal speed, the flame motions are slowed down over two hundred times, thereby facilitating close inspection and analysis of the motions. Improvements in the design of oil circuit breakers has been possible by high speed photography of circuit breakers.

Slow motion photography helps one to analyze the rapid movements of birds, animals and athletes. It is well known that the slow motion studies of the flight of birds have a considerable research value in their relation to aeronautical problems. Slow motion studies of fish have been very helpful to ship designers. Fertilization in flowers has also been studied by this method.

Animated pictures.—The methods used in the construction of "Mickey Mouse" and other

animated pictures find application in the production of scientific films. Complicated pictures of scientific nature and particularly those that are impossible to be photographed—the imaginative and impossible situation—lend themselves to this particular technique. All animated cartoon on the operation of the internal combustion engine is an example of such films. Animated representation of complex organic reactions is of considerable value in showing and explaining organic chemical synthesis. It is stated that H.T. Clarke of the Eastman Research Laboratories has prepared a film showing both schematic and actual preparation of several organic compounds. The process, however, is very tedious as it requires considerable time to draw the pictures and also it involves special technique.

Microcinematography.—The application of microcinematography to research work offer great opportunities. It has been used in the study of bacterial life. A microcinematographic equipment which can be used in research laboratories has been devised by Heinz Rosenberger of Rockefeller Institute for medical research. This apparatus has been used in the production of film on living cells and on Leishmanias and Trypanosomes. A new apparatus for making microscopic movies has been designed by the Eastman Kodak Company in collaboration with the Bausch and Lamb optical company. Cine-Kodak Special may be used with a special observation eye piece which acts as a beam splitter. This eye piece is fitted in front of the camera in place of the regular camera lens. By means of a prism in the beam splitter part of the light is reflected to the film and part is transmitted through the eye piece so as to enable the operator to examine the object which is being filmed.

Infra-red ray cinematography. Infra-red ray cinematography can be applied to the study of problems in which the use of visible light is not desirable. It has been applied successfully for the diagnosis of mental and nervous complaints of patients. One of the methods of diagnosis of such symptoms is to take films of the patient's eye while he is startled by pistol shots. This forms part of the new science called Pupillography. The films are taken in the dark with the help of infra-red rays as visible light causes contraction of the eye pupil. The movements of the pupil of the eye caused by the hearing of the pistol shots are recorded on the film, and from the study of the nature of the movements it is possible to diagnose the complaints from which the patient is suffering. Professor Lewenstein, a refugee in Switzerland from Nazi persecution, is the originator of this new technique.

X-ray cinematograph.—X-ray cinematographic technique is now being applied to the study of the function and movements of organs and limbs in health and disease. In addition to the common variety used in surgery, softer rays which are more useful to record the internal working of creatures too delicate in structure to be photographed by the ordinary hard rays, are more widely used for X-ray movies.

The main difficulty in the production of X-ray movie films is that rays cannot be refracted like light and they cannot be focussed by a lens. The X-ray picture is, therefore, projected on to a bright fluoroscopic screen and the projected picture is photographed with a movie camera. For this purpose a special camera with an extremely strong objective should be used. Highly sensitive films should be used, for the purpose. X-ray films showing the movements of elbows, shoulder joints, the expansion and contraction of the heart in beating, the function of stomach etc., have been produced. An X-ray film of a woman's digestive process was recently produced in Rochester. Such films are extremely useful for purposes of teaching and demonstration, and they possess high medical value. The movements of the diaphragm during respiration, coughing and speaking have been recorded on film by means of this technique. These films are now being used in developing a system of instruction for singers and actors, by observation of the movements of the organs of the upper respiratory tracts. Such films are said to open up new possibilities for the didactics of speaking and specially for the education of deaf mutes.

Scientific Films—A Neglected Subject in India

This short survey gives an idea of the many applications of cinematography in scientific education and research and its future developments. While moving pictures have been used for teaching, scientific and research purposes to a great extent for a number of years in other countries, such as Great Britain and U.S.A., their use has been distinctly limited and totally neglected in India. The immense value of the film as a scientific document is not yet realized in our country. The production of scientific films no doubt attended with many difficulties. Their production is not a commercial proposition as they cannot compete with the ordinary popular entertainment films. The technique of their production involves highly specialized talent and skill. In Great Britain and U.S.A., a number of scientific institutions and universities are now producing and showing scientific films. We are woefully lacking in this enterprise. Some of the few scientific films which we see in India are produced by Rockefeller Foundation dealing with disease like malaria, hook worm and other health subjects. These are used for propaganda in the villages by Public Health Departments. Some of the films, *e.g.* on nutrition, are based on western standards and customs which may not be quite appropriate to Indian condi-

tions. It is, therefore, necessary to produce such films based on Indian standards and conditions of living. . With the help of films the general public at large should be told something of the work of scientists and how science affects their work in the public interest. For example, farmers must know how scientific research in agriculture affects their crops and their activity in the field. Such interpretative films bring out the relations of science to society and aim at solving the difficulties arising out of developments and changes in science and society. It is gratifying to know that attempts are being made in this direction by the Information Films of India to produce such interpretative films. A scheme has recently been inaugurated in Bombay under which educational films will be shown on Sundays at certain Bombay cinema houses for the benefit of students. The scheme is jointly sponsored by the Information Film of India and the Headmasters' Association of Bombay. In England and other countries some of the theatres such as the Shaftesbury Avenue, London, show scientific films very frequently. Nature films produced by the British Educational Films are very frequently shown in these theatres. A far more comprehensive and elaborate scheme should be formulated on similar lines for the film to be of any real use to the student and the public at large in the field of science in India.

Wanted An All India Scientific Film Association

In addition to such interpretative films, there is great scope and need for the production of research films. The vastness of the field of application of the film to scientific research justifies more attention to be paid by scientists, and the infinite possibilities that the production and use of such films in research institutions open up should attract a very large number of scientists to the technique of film production. It is high time that a central organization, an All India Scientific Film Association similar to the Scientific Film Association of Great Britain, should be created in India to collect information about scientific films, to explore the possibilities of borrowing films produced by scientists and scientific institutions in other countries for the use of research institutions and universities in India, to draw up a programme of production of scientific films on various subjects, and to advise and render technical assistance to those who are anxious to produce scientific films. The various scientific bodies in India which sponsor research schemes should set apart a small grant for the production of scientific films. Research workers and others who desire to produce scientific films on subjects approved by a special committee appointed by the central organization may be granted funds for the production of such films. Scientific research films if produced on proper lines would be of considerable value to workers in other and allied fields of research. It is also desirable to have small scientific film units in scientific institutes and universities to film some of the important experiments and results of research in progress. Some day, we hope, scientific films will be produced under the direction of universities and scientific institutions in our country as a definite part of their activities.

References

1. Harris, P., *Nature*, *142*, 834, 1938.
2. Fuller, A. B. and Eaton, W. W., *J. Soc. Motion Pictures*, *34*, 334, 1940.
3. Rassweiler, G. M. and Withrow, L., *Ind Eng Chem.*, *28*, 672, 1936.

FINGER AND PALMAR PRINT OF THE INDIAN JUVENILE CRIMINALS

P. C. BISWAS,

DEPARTMENT OF ANTHROPOLOGY, CALCUTTA UNIVERSITY

Introduction

THE following work is the investigation on the finger and palmar pattern of the fifty juvenile criminals of the Industrial and Reformatory Schools at Alipur in Bengal.

The materials for the following investigation are hundred palmar and five hundred finger prints.

In the following tables, are shown the occurrence of Whorl, Loop (both open to the ulnar and radial sides) and Arch in absolute number and in percentages. (Table I & II).

TABLE I

Finger	Whorl			Loop						Arch		
				Radial			Ulnar					
	R	L	T	R	L	T	R	L	T	R	L	T
1st	26	24	50	—			24	25	49		1	1
2nd	18	16	34	2	6	8	25	23	48	5	5	10
3rd	14	13	27	2	1	3	31	34	65	3	2	5
4th	24	19	43	—			24	29	53	2	2	4
5th	10	10	20	—			38	37	75	2	3	5

TABLE II

Finger	Hand	Whorl	L. (Radial)	L. (Ulnar)	Total	Arch
	Both	50·0	...	49·0	49·0	1·0
1st	Right	52·0	...	48·0	48·0	0·0
	Left	48·0	...	50·0	50·0	2·0
	Both	34·0	8·0	48·0	56·0	10·0
2nd	Right	36·0	4·0	50·0	54·0	10·0
	Left	32·0	12·0	46·0	58·0	10·0
	Both	27·0	3·0	65·0	68·0	5·0
3rd	Right	14·0	4·0	62·0	66·0	6·0
	Left	13·0	2·0	68·0	70·0	4·0
	Both	43·0	...	53·0	53·0	4·0
4th	Right	48·0	...	48·0	48·0	4·0
	Left	38·0	...	58·0	58·0	4·0
	Both	20·0	...	75·0	75·0	5·0
5th	Right	20·0	...	76·0	76·0	4·0
	Left	20·0	...	74·0	74·0	6·0

The different types of pattern (whorl, loop and arch) occur in the following proportion. Whorl occurs in 34·8 per cent (174), Loop occurs in 60·2 per cent (301), among them loop opening to the radial is in 2·2 per cent (11) and loop opening to the ulnar side is in 58·0 per cent (290). The pattern arch appears in 5·0 per cent (25). Table III.

TABLE III

OCCURRENCE OF PATTERNS W, L^r, L^u, A IN ABSOLUTE NO. AND IN PERCENTAGES AMONG 500 FINGERS

Types of Pattern	Absolute No.	Percentages
Whorl (W)	174	34·8
Radial Loop (L^r)	11	2·2
	301	60·2
Ulnar Loop (L^u)	290	58·0
Arch (A)	25	5·0

Table IV shows the occurrence of different types of pattern which appear on the fingers of the criminals of different nations (including the results of the author's investigation).

TABLE IV

Nations	Whorl	Loop			Arch	Author
		Radial	Ulnar	Total		
Chinese	51·5	2·7	43·7	46·4	2·0	Abel
Chinese	50·66	2·66	45·03	47·69	1·40	Kubo
Korean	45·18	3·15	48·71	51·86	2·62	Kubo
Ritoto	45·70	3·43	48·60	52·03	1·90	Kubo
Ichigaga	45·16	3·84	48·92	52·76	1·81	Kubo
Japanese Lugano	45·18	4·2	47·65	51·85	2·62	Furuse
Norwegian	25·65	5·81	61·14	66·95	7·40	Bonevie
Italian	36·46	4·44	54·00	58·44	4·72	Falko
German	33·70	...	...	60·92	5·38	Muller
Indian	34·8	2·2	58·0	60·2	5·0	Biswas

In the table below it is given how the different pattern types have appeared within the normal and criminal Indians. From the table it appears that there is no marked difference in the occurrence of the pattern types among the normal and criminal Indians.

TABLE V

	Whorl	Loop			Arch	Author
		Radial	Ulnar	Total		
Indians (normal)	36·1	2·7	59·2	61·9	1·6	Schlaginhaufen
Indians (normal)	42·5	2·75	52·5	55·25	2·25	Biswas
Indians (criminal)	34·8	2·2	58·0	60·2	5·0	Biswas

PALMAR PRINTS

In studying one hundred palmar prints of fifty Indian criminals I have found 15 different types of formula in the right hand and 20 in the left hand. In the normal Indians, about the same number and similar formulae have been obtained.

TABLE VI

No.	Criminal Right	Normal Right	Criminal Left	Normal Left
1.	7.5.5.4	7.5.5.3	7.5.5.2	7.5.5.1
2.	7.5.5.5	7.5.5.4	7.5.5.3	7.5.5.3
3.	9.×5.4	7.5.5.5	7.5.5.4	7.5.5.4
4.	9.0.5.5	9.7.5.3	7.5.5.5	7.5.5.5
5.	9.9.5.4	9.7.5.4	9.×5.4	7.7.5.3
6.	9.9.5.5	9.7.5.5	9.×5.5	9.7.5.1
7.	9.7.5.4	9.9.5.4	9.0.5.3	9.7.5.3
8.	9.7.5.5	10.0.7.5	9.0.5.4	9.7.5.4
9.	11.7.7.5	11.7.7.5	9.0.5.5	9.7.5.5
10.	11.11.9.5	11.9.7.1	9.9.5.4	9.0.5.5
11.	11.0.7.4	11.9.7.4	9.9.5.5	9.9.5.1
12.	11.0.7.5	11.9.7.5	9.7.5.1	9.9.5.3
13.	11.9.7.1	11.11.8.6	9.7.5.4	9.9.5.4
14.	11.9.7.4	11.11.9.5	9.7.5.5	9.9.5.5
15.	...	...	11.7.7.4	10.7.6.3
16.	...	...	11.0.7.5	10.0.7.5
17.	...	...	11.7.7.5	11.7.7.3
18.	...	...	11.9.7.1	11.7.7.5
19.	...	...	11.9.7.4	11.9.7.3
20.	...	...	11.9.7.5	11.9.7.4
21.	...	...	...	11.9.7.5

The frequency of different endings of the four main lines D, C, B and A of fifty right and fifty left hands of the fifty Indian juvenile criminals, is given in Table VIII. The line D ends on 7 in 15·0 per cent, on 9 in 40·0 per cent and on 11 in 45·0 per cent. The line C ends on 0, 5′, 7, 9, and in 11·0 per cent., 13·0 per cent., 24·0 per cent., 45·0 per

cent and 4·0 per cent respectively. The line B ends on 5, 5′, 7 in 17·0 per cent., 38·0 per cent and 44·0 per cent respectively. The line A ends in 1, 3, 4, 5, and 51 in 4·0 per cent., 3·0 per cent., 42·0 per cent., 47·0 per cent and 3·0 per cent respectively.

TABLE VII

FREQUENCY OF ENDINGS OF THE FOUR MAIN LINES D, C, B, AND A IN PERCENTAGES

r (right), l (left), m (mean)

Ending	L.D.			L.C.L.C.			L.B.			L.A.		
	r	l	m	r	l	m	r	l	m	r	l	m
0	...	...	...	8·0	14·0	11·0	...	...	...	...	...	...
1	...	...	...	...	...	...	...	...	...	2·0	6·2	4·0
2	...	...	...	...	...	...	...	...	...	0·0	2·0	1·0
3	...	...	...	...	...	...	...	...	...	0·0	6·2	3·0
4	...	..	...	...	...	...	...	...	...	36·0	48·0	42·0
5	...	...	...	0·0	4·0	2·0	8·0	26·0	17·0	56·0	38·0	47·0
5′	...	...	...	12·0	14·0	13·0	36·0	40·0	38·0	6·0	0·0	3·0
6	...	...	...	...	...	...	...	...	...	...	...	...
7	12·0	18·0	15·0	16·0	32·0	24·0	54·0	34·0	44·0	...	...	...
8	...	...	...	...	...	...	...	...	...	...	...	...
9	32·0	48·0	40·0	60·0	30·0	45·0	2·0	0·0	1·0	...	...	...
10	...	...	...	...	...	...	...	...	...	...	...	...
11	56·0	34·0	45·0	2·0	0·0	1·0	...	...	...	...	...	...
...	...	...	...	2·0	6·0	4·0	...	...	...	...	...	...

Among the different types of formula, the formulae 11. 9. 7.—, 9. 7. 5.—, and 7. 5. 5.—appear in larger number.

TABLE VIII

Formula	Rt. Hand	Lt. Hand	Total
11.9.7. ..	24·0%	9·0%	33·0%
9.7.5. ..	7·0%	11·0%	18·0%
7.5.5. ..	6·0%	9·0%	15·0%

No striking difference exists in the occurrence of the above three main line formulae on the normal and criminal Indian's hand. One can see a slight difference in the occurrence of the main line formula 9. 7. 5.—. In the normal Indians' hand the formula 9. 7. 5.—occurs in lesser percentage than that of 7. 5. 5.—. Whereas in the Indian criminal it occurs in quite the reverse way. (See table below).

TABLE IX

Formula	Normal Indians (Schlaginhaufen)	Normal Indians (Biswas)	Criminal Indians (Biswas)
11.9.7.— ..	44·2%	46·0%	33·0%
9.7.5.— ..	11·5%	15·0%	18·0%
7.5.5.— ..	15·4%	18·0%	15·0%

PATTERN ON THE HYPOTHENAR AREA

Patterns on the hypothenar area of the human palm are mainly loop and rarely whorl and figure 'S' and other minor patterns. In my criminal data I have got the following patterns:—

TABLE X

Pattern	Right	Left	Sum
L^u ..	6 (12·0%)	4 (8·0%)	10 (10·0%)
L^r ..	7 (14·0%)	8 (16·0%)	15 (15·0%)
W ..	2 (4·0%)	1 (2·0%)	3 (3·0%)
S ..	1 (2·0%)	2 (4·0%)	3 (3·0%)
A^c ..	2 (4·0%)	2 (4·0%)	4 (4·0%)
A^u ..	0 (0·0%)	1 (2·0%)	1 (1·0%)
A^r ..	1 (2·0%)	0 (0·0%)	1 (1·0%)

TABLE XI

FREQUENCY OF PATTERN LOOP ON THE 100 CRIMINAL HANDS

Pattern	Right	Left	Sum
Loop ..	13 (26·0%)	12 (24·0%)	25 (25·0%)

In the frequency of occurrence of the pattern loop on the hypothenar area there lies a marked difference between the normal and criminal Indians. Schlaginhaufen working among the normal Indians, has got 42·5 per cent and Biswas has got 32·0 per cent. In the Indian criminal it appears in 25·0 per cent. (See table below).

TABLE XII

COMPARATIVE TABLE OF THE OCCURRENCE OF PATTERN LOOP ON THE HYPOTHENAR AREA OF THE INDIAN CRIMINAL AND NORMAL

	Frequency in %	Author
Indians (Normal) ..	42·5 37·25	Schlaginhaufen
Indians (Normal) ..	32·0	Biswas
Indians (Criminal) ..	25·0	Biswas

PATTERN ON THE THENAR AREA

On the criminal hand as well as the normal, patterns occur in lesser percentage on the Thenar area than that of the Hypothenar. In the table below it is given how the patterns appear on the Thenar area of the criminal Indians:—

TABLE XIII

Pattern	Right	Left	Sum	Per cent.
Loop	2	3	5	5·0
Multiplication ..	1	1	2	2·0
Vestige	0	1	1	1·0
Whorl	0	1	1	1·0

In the table XIV I have given how the pattern loop on the Thenar area, occurs on the palm among the normal and criminal Indians. It occurs in 15·3

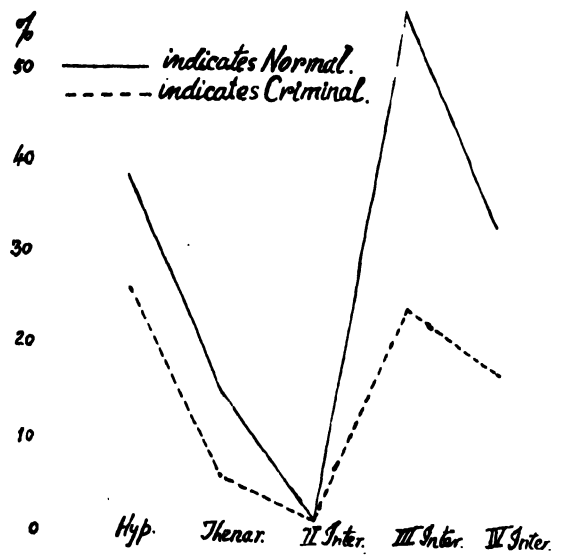


FIG. 1.

per cent among the normal Indians according to Schlaginhaufen and according to Biswas it occurs in 13·3 per cent. Whereas on the criminal hand it appears in 5·0 per cent.

TABLE XIV

	Frequency in %	No. Hand	Author
Indians (Normal)	15·3	52	Schlaginhaufen
Indians (Normal)	14·15 13·3	100	Biswas
Indians (Criminal)	5·0	100	Biswas

TABLE XV

FREQUENCY OF PATTERN LOOP ON THE THENAR AND HYPOTHENAR AREA IN PER CENT

	Thenar	Proportion	Hypothenar
Indians (Normal) ..	15·3	1 :2·7	42·5
Indians (Normal) ..	13·0	1 :2·5	32·0
Indians (Criminal) ..	5·0	1 :5·0	25·0

PATTERN ON THE IIND, IIIRD, AND IVTH INTERDIGITAL AREAS

On the IInd Interdigital area like the normal individual no loop occurs. Only neben-triradius occurs in 7·0 per cent. On the IIIrd Interdigital area pattern loop occurs in 23·0 per cent (16·0 per cent on the right and 7·0 per cent on the left), on the IVth Interdigital area both loop and neben triradius in 20·0 per cent., (10·0 per cent on the right and 10·0 per cent on the left) (Fig. 1). Below is given a comparative table showing the occurrence of loop on IInd, IIIrd, and IVth Interdigital areas of the normal and criminal and normal Indian's hand.

TABLE XVI

	Area IInd	Area IIIrd		Area IVth		Author
Indians (Nor.)	*	61·5	55·1	34·6	32·3	Schlaginhaufen
Indians (Nor.)	*	49·0		30·0		Biswas
Indians (Cri.)	*	23·0		16·0		Biswas

AXIAL TRIRADIUS

I have noted below how the axial-triradius appeared in the criminal hand.

TABLE XVII

Triradius	Right	Left	Total	Per cent.
t	34	33	67	67
t'	0	1	1	1
t''	0	0	0	0
pt'	5	7	12	12
tt'	7	6	13	13
tt''	1	1	2	2
pt't'	1	1	1	1
tt'	1	0	2	2
pt't'	0	1	1	1
p	1	0	1	1

There is no appreciable difference in the occurrence of axial-triradius in the palm of the criminal and normal Indians.

CONCLUSION

As a result of my investigation of the finger and palmar prints of the Indian criminal, it appears that there is no marked difference in the finger prints pattern of the criminal and normal Indians.

It is very interesting that in the appearance of pattern loop on the Hypothenar, Thenar, and on the three Interdigital areas a considerable difference exists on the palm of the criminal and normal Indians. The pattern loop occurs in considerably lower number in the above areas of the criminal hand than that of the normal individual. In the Main-line formulae and the Axial-triradius there are no such difference.*

* I have to thank Prof. K. P. Chattopadhyay for his kind help and suggestions about the work. I am also indebted to Mr Bottomley, formerly Director of Public Instruction of Bengal and to the Superintendent of the Industrial and the Reformatory Schools at Alipur for giving me the necessary facilities for my investigation regarding the inmates of the Alipur Industrial and Reformatory Schools.

OBITUARY: PROFESSOR HARAPRASAD CHAUDHURI

IT is with deep sorrow, we record the death of Professor Haraprasad Chaudhuri, M.Sc. (Cal.), Ph.D., D.Sc., D.I.C. (Lond.), F.N.I., Head of the Department of University Teaching in Botany and Director, Kashyap Research Laboratory, Panjab University, which melancholy event occurred at his Calcutta residence on Sunday, the 19th August last at 9-20 A.M. His premature death is a great loss to the country. He was suffering from high blood pressure,



PROF. HARAPRASAD CHAUDHURI

since February last, which developed into uraemia, from the effects of which he did not recover. Prof. Chaudhuri only 50 years of age at the time of his death.

Born of a respectable family of Chaudhuri's of Janai Baksha, district Hooghly, on 28th July 1895 at Calcutta, Prof. Chaudhuri was the son of late Dr Janmejoy Chaudhuri, B.A., L.M.S. He had his early education at the Deoghar H. E. School, from where he matriculated in 1912. Entering the Bangabasi College, Calcutta the same year, young Chaudhuri came in contact with the late Principal G. C. Bose, whose influence played a great part in shaping his botanical career. He graduated in Science, with distinction in 1916 and obtained his Master's degree in Botany in 1918, at the Presidency College, Calcutta. Signs of his later career in botanical investigation were manifested by Chaudhuri, even in these early years and he published a thoughtful note entitled 'Laziness in Plants' (*Presidency College Magazine*, 4, 2, 1917).

When the call of the country demanded young Chaudhuri was not slow in responding to it, and enlisted into the Calcutta University Corps of the Indian Defence Force and underwent a full course of training ready to offer himself for active service when the World War I came to an end.

With the opening of the Botany Department of the University College of Science and Technology, Calcutta, in 1918 Chaudhuri was the first recipient of the Sir Rash Behary Ghosh Research Scholarship in Botany, of the Calcutta University. The Ghosh Professor of Botany, having not arrived from Europe as yet, he was attached to Prof. S. N. Bal, Assistant Professor of Botany, Calcutta University (now Curator, Indian Museum).

His first paper in mycology entitled 'Meliola growing on *Phoenix Sylvestris* and *Citrus medica* var *acida* appeared in the *Journal of the Department of Science*, C. U., I, 1919. The interest created in him in the citrus diseases, kept him engaged all through his career in mycological investigations. He also contributed a paper "*Cephalcurus Virescens* Kurzi, to the Sir Ashutosh Mookerjee Silver Jubilee Commemoration, Vol. 2 (Science).

In 1920, he joined the Imperial College of Science and Technology, London, as a research student, in the Department of Plant Physiology and Pathology, under Prof. V. H. Blackman, F.R.S. and was duly admitted to Ph.D. (London) and Diploma of the Imperial College in 1922. A part of his thesis on 'a study of the growth in culture of *Verticillium albo-atrum* Bet. Br.' was published in *Annals of Botany*, 37, 1923.

On his return to India, in the same year, he was appointed a Reader in Botany in the Panjab University, Lahore. Investigations on the physiology of "Saltation in Fungi", commenced by him in London was further continued. 'A description of *Colletotrichun biologicum* nov. sp. and observations on the occurrence of a saltation in the species, appeared in the *Annals of Botany*, 38, 1924. Later, in 1931 (*Jour. Ind. Bot. Soc.*, 10) he observed that saltation in fungi is a nutritive phenomenon (nutritive saltation), unless it be a mutation which is of rare occurrence.

As a teacher, he could not but be alive to the paucity of suitable books in India for teaching purpose, and himself published 'A practical introduc-

tion to the study of Botany', specially intended for India, in collaboration with late Sir John Farmer, F.R.S.

In 1919, he married Miss Lotica Bose, eldest daughter of the reputed scholar and Calcutta Parrister, late Mr H. D. Bose, and in 1927, accompanied by her he went to Europe on study leave and toured the whole of the continent. In connection with his research work he went to England for a third time in 1934.

On the death of Prof. Rao Bahadur Lala Shiv Ram Kashyap in the same year, Prof. Chaudhuri succeeded him and was also appointed the director of a new laboratory donated by the public, to commemorate the work of late Prof. Kashyap and named 'Kashyap Research Laboratory'.

In 1938, he was one of the three delegates from India who attended the 12th International Horticultural Congress at Berlin. At the invitation of the German organizers of the Congress, Prof. Chaudhuri had the honour to be the first president of the 'Tropical Section' of the Congress and delivered the presidential address. He also represented the Botanical Society of Bengal at this Congress.

On the merits of his published research work in Mycology and Plant Pathology, the University of London admitted him to the D.Sc. in 1930. The total number of papers published by him and his students are too numerous for complete enumeration. Along with his students he worked on a variety of fungi, including soil, aquatic, and coprophilous fungi, slime moulds, bacteria including bacterial diseases of wheat and mycorrhiza.

Chaudhuri and Rajaram, in 1925, made some interesting observations regarding mycorrhiza in *Marchantia nepalensis*. The endophyte was isolated and by means of inoculation experiments, a reciprocal symbiosis has been shown to exist. The green plant supplies the fungus with carbohydrate and the specific endophyte is necessary for the formation and maturation of the sporophyte generation (Flora 22).

Chaudhuri also published a report on the citrus diseases of the Punjab (1930-35), an investigation financed by the I.C.A.R. These include wither-tip anthracnose, chlorosis, and diseases due to saprophytic fungi. His last monographic work on citrus diseases in India is still in the press. Chaudhuri and his students also studied the various diseases of the tea bush, orchards and vegetable crops and also the effect of X-rays and ultra-violet rays on the physiology of certain fungi. His last paper, a note on the life history of *Rhinosporidium*, found on the nasal and faecal excretions of cows, bullocks and ponies, appeared this year in the *J. I. B. S.*, 24.

He was elected to preside over the Botany section of the 19th session of the Indian Science Congress, held at Bangalore in 1932 and he delivered an address on "The science of plant life in India—past and present." As president of the Indian Botanical Society, he delivered an address on "A plea for better co-ordination of Botanical work in India" (*J. I. B. S.*, 20, 1941), at the 20th annual meeting of the Society held at Benares.

He was elected a foundation fellow of the National Institute of Sciences of India in 1935, Vice-President, Botanical Society of Bengal, and Hony. Secretary, Lahore Horticultural Society.

Dr Chaudhuri took active interest in the academic affairs of the Panjab University, where he introduced Bengali as a second language in the Panjab. He was appointed a member of the Post-War Reconstruction Committee, of the Faculty of Science, Panjab University, but his untimely death has left the work unfinished.

He took to trekking as a hobby and every year he held the Botany summer school with his students in the Himalayas.

He was Secretary, Bengali School, Lahore, Trustee, Lahore Cantonment Kalibari, and Banga Lakshmi Stores etc.

He was loved and held in high esteem by his students and colleagues alike and was a popular figure among the scientists in India.

His memory will be long cherished by his pupils, relatives and friends.

A. K. G.

Notes and News

OBITUARY: C. S. MIDDLEMISS

We regret to announce that Mr C. S. Middlemiss C.I.E., F.R.S., F.A.S.B., the *doyen* of Indian Geologists and a former Superintendent, Geological Survey of India (1883-1917) died on June 11 last, aged 85 years. Middlemiss gave an account of the Geology of Salt range with a reconsidered theory of origin and age of the salt marl in 1891 (*Rec. G. S. I.*, 24). He surveyed the Kangra earthquake of 4th April, 1905 (*Mem: G. S. I.*, 38, 1910) and also worked on the stratified formations of Kashmir (1908-17) that enabled him to make perfect classification of Kashmir record. He presided at the Geology section of the Indian Science Congress, held at Bangalore, 1917 and delivered an address entitled "Complexities of Archaean Geology".

He later surveyed the minerals of the Kashmir State as the State Geologist and published 'Economic reports on mineral resources of Kashmir State' (1930-35).

For fuller details of his career the readers are referred to SCIENCE AND CULTURE, Vol. 3, 1938 (Science Congress Supplement).

GEOPHYSICAL PROSPECTING

The application of the geophysical methods of prospecting for new mineral deposits is of comparatively recent origin and has revolutionized old practices of mineral exploration. The recent discovery of fresh oil beds in Saudi Arabia, the story of which has been told by the scientific delegation that visited the U.K., the U.S.A., and Canada, has been largely the outcome of prospecting by geophysical methods. The success of these new methods has not, however, been confined to Saudi Arabia alone; the new science of geophysics, as Dr G. M. Lees, of the Anglo-Iranian Oil Company Ltd., reports in *Nature*, May 12, 1945, has played a vital role in oil exploration in Great Britain.

Only some ten years ago, the geologists in Great Britain generally believed in the impossibility of anticipating oil pools of commercial magnitude in any known part of Great Britain, and exploration of oil was regarded as a hopeless task. This conclusion was arrived at after careful and intensive search for oil over every inch of land by traditional geological methods. The results of exploration for oil by the D'Arcy Exploration Company (subsidiary of the Anglo-Iranian Oil Company) employing geophysical methods of prospecting has now given the lie to such conclusions. The company has been in active operation for nearly ten years and has succeeded in proving five oil fields and two areas of natural gas, the 243 wells of which produced a total of 337,000 tons of mineral oils up to the end of 1944. The crude oil, with specific gravity ranging from 0·83 to 0·89, is reported to be of good quality, yielding good light and lubricating oil fractions.

Oil fields have been discovered in the neighbourhood of Newark, Duke's Wood, Caunton and Kelham Hills, Formby, Nottinghamshire and other places. Besides, the existence of a number of gas fields has been proved at Aislaby in Eskdale, North Yorkshire and at Consland near Dalkeith, Scotland. The Nottinghamshire oil fields were discovered as a result of intensive geophysical work carried out by the staff of the Anglo-Iranian Oil Company. Of the various geophysical methods applied, seismic refraction are surveys, gravity and magnetometer methods are reported to have yielded highly useful results. The presence of a number of structural highs in extensive areas in Eastern Nottinghamshire and in Lincolnshire has been proved by these investigations and verified in some cases by actual drilling.

Furthermore, these investigations have resulted in the collection of new and important geological information on the statigraphy and structure of the carboniferous rocks below the Permian unconformity. In addition to mineral oils, these surveys based on geophysical methods have led to the discovery of coal seams of significant thickness at Spital, Dunston, Stixwould, of potash salts of Permian age in Eskdale, North Yorkshire, and also of sylvite and polyhalite deposits.

It will be of considerable interest to note that geophysical methods have recently yielded valuable results in the prospecting for manganese in India. In a recent paper in the *Journal of Scientific and Industrial Research*, (June, 1945), B. L. Gulatee, of the Survey of India, discusses the results of application of the geophysical methods to locate hidden deposits of manganese ores in the alluvial area of Parsoda in the Central Provinces. The Gradiometer which is a modification of the Fötvos Torsion Balance was employed owing to the higher density of manganese. The main reef was successfully located, and the pattern of the profiles obtained in the area agreed with the geology of the region previously established. The method, it is concluded, can be successfully employed in the location of ore bodies completely

hidden under alluvium, since it gives valuable preliminary indications to be confirmed by actual borings and eliminates huge expenditure involved in random sinking of pits.

BOTANICAL SURVEY OF INDIA

THE report of the Botanical Survey of India for 1944-45, issued recently, gives an indication of the keen interest shown by both Government Departments and the commercial public in the availability and quality of crude drugs of vegetable origin. In the pharmacognostic laboratory recently built up under the auspices of a Calcutta firm, a number of drugs have been studied and the results published in this journal and elsewhere. Mr Bal, a member of the Indian Pharmacopoeial List Committee of the Government of India, carried out the pharmacognosy of a large number of Indian medicinal plants that are to be listed in the "Indian Pharmacopœia". A large number of economic enquiries from the Government and the public, relating to pharmacopœial drugs, insecticides, rubber-yielding plants, plants used in perfumery trade and the like, were replied to. Numerous economic products were identified for official and non-official parties.

While the economic botany section received the necessary attention, it is really unfortunate that floristic study in the field was kept in abeyance on account of the war. Specimens were, however, collected for the herbarium by the Superintendent, Royal Botanic Garden, Sibpur, who made tours in the Darjeeling district for the purpose.

THE INSTITUTE FOR THEORETICAL PHYSICS

WE have reported from time to time the tragic fate of scientific and research institutes in Europe, particularly in Soviet Russia, during Nazi occupation. Destruction of the centres of research and learning and persecution of scientists failing to fall in line with the Nazis became a mad orgy with the Nazi leaders, and its reaction on the cultural and scientific life of the nations of Europe will be visible for generations to come. Against such a dismal background, much satisfaction will be felt at the news (*Science News Letter*, June 7, 1945) that the Nazis, during their occupation of Denmark, did not touch the famous Institute for Theoretical Physics at Copenhagen where Prof. Niels Bohr worked and of which he is the Director. Bohr is a jewish physicist and won Nobel Prize in 1922 for his theory of the atomic structure. Fear of persecution led him to leave Copenhagen for Sweden in October 1943, whence he later escaped to England. Prof. George Hevesy, the Hungarian chemist and Nobel Prize winner in 1943 for research on 'Heavy Water', accompanied him for similar reasons. On December 6, 1943, shortly after their escape, the Nazis took possession of the Institute on the pretext that Bohr was actively engaged in helping the war-effort of the Allies. They further imprisoned Bohr's assistant, Dr Boeggild, for 7 days and locked up the laboratory foreman for 10 days as a measure against possible Danish sabotage of the laboratory. The Nazis tried to place the Institute under German physicists, but failed to persuade any competent physicist in Germany to undertake control of the Institute which was later returned to the University of Copenhagen.

Prof. Bohr is now reported in the United States where he is believed to have been working on the atom bomb. He is shortly expected to return to Copenhagen. The exodus of scientists, it is of interest to note, included the distinguished physiologist, Prof. August Krogh who obtained Nobel Prize in medicine and physiology in 1020. Prof. Krogh is still in Sweden and was recently threatened with death by the Nazis.

The war has completely disorganized scientific activity in the occupied territories of Europe. An exodus of leading scientists and literary men from Europe to the U. S. A. followed the outbreak of the war ; but several remained in their homeland to be put to serious difficulties often involving life, the story of which is now gradually appearing in the Press. Scientists in Europe will leave a sigh of great relief and security now that the nightmare of war and persecution is over. We rejoice with them in their ability to return to their natural home, the laboratory, and resume work.

THE SEVERN BARRAGE SCHEME

A saving of about one million tons of coal per annum is expected to result from the proposed dam across the Severn, which, according to a report in *Nature*, will be the largest single source of electrical energy in Great Britain. The Severn Barrage Scheme, formulated by Mr A. G. Vaughan-Lee, Sir William Halcrow and Mr S. B. Donkin, proposes to build a dam at English Stones on the Severn, which will utilize the hydro power of the rising tides. The dam will be provided with inlet sluices, navigation locks and 32 turbines. These turbines, in equal groups, would drive 32 alternators, each rated 25 MW. at 0·9 power factor. The water stored by the dam during rising tides will be released through these turbines on the succeeding falling tides, producing electrical energy. The available power outlet will be greatest at spring tide, being about 800 MW. The plant would usually generate power and energy in two periods of about seven hours during each 24 hours. On this basis, the gross energy available at the barrage has been estimated at 2,365 million KWh. per annum.

The estimated requirement of 6,585,000 tons of civil engineering materials, cement, stone, sand and gravel, 89,000 tons of steel and 5,000 tons of copper, for the construction of the dam, reflects the magnitude of the project. The constructional time will be roughly 8 years, during which 10,355 persons, on an average, have to be maintained in service. The total cost of the barrage has been estimated at £40·22 million, that is, £50 per KW. of plant installed. The electrical energy would cost 0·199 *d* per KWh. at the barrage.

Judged from conventional economic standpoint, the tidal scheme does not appear to offer bright prospect. The cost of £50 per KW. of installed plant compares unfavourably with that of £30 per KW. for a thermal power station. The power output for tidal stations is also very low, being about 47 per cent as against 85 per cent for thermal station. But the great saving of coal whose supplies in Great Britain have become deficient in quantity and in quality may override economic considerations.

THE ANUP SANSKRIT LIBRARY

THE Anup Sanskrit Library belonging to the ruling family of Bikaner is an invaluable library prized for its great antiquity and possession of very rare and important works. From a note prepared by Dr C. Kunhan Raja, Head of the Sanskrit Department, Madras University, and sent to us by the Director of Publicity to the Government of Bikaner, we learn that the library developed out of the rich collection of manuscripts in the Fort at Bikaner. The library has a history of four hundred years, its first manuscripts having been collected as early as the middle of the 16th century. The collection includes many works written by the members of the Bikaner Reigning Family and by the scholars and poets patronized by the kings of Bikaner. These writings and rare works throw important light on the culture and civilization that obtained in India in the middle ages. For instance, mention may be made of the work 'Rayasimhotsava' by Raja Rai Singhji, a great poet and scientist, who ruled during the latter half of the 16th century. It is a work on medicine, divided into 64 chapters, and deals with all topics connected with the science and practice of medicine. Thus, preventive medicine, symptoms and diagnosis of diseases, treatment of diseases, medicines and their preparation, maternity, children's ailments and their cure, diagnosis of the eye, throat, etc. and pains and their cure are among the subjects discussed in detail in the work. The work appears to have been written as a practical guide to the medical department of the State in his time, and the Maharaja himself undertook to compile for the benefit of his people all the latest available facts in medicine. It is stated that arrangements have been made to publish important works.

MICRO-BIOLOGY IN GREAT BRITAIN AND IN THE COLONIES

GREAT interest in micro-biology is now widely visible in Great Britain directly as a consequence of the impact of war. The war has demonstrated the important part micro-biology has had to play in the nation's food production. If the lessons of the war are not to be overlooked during peace time, research in this science must continue to receive greater support and encouragement. It is, therefore, reassuring to learn that a Society for General Microbiology has been formed, with Sir Alexander Fleming as its President and Drs L. A. Allen of Water Pollution Research Laboratory and R. T. St. John-Brookes of Lister Institute as Secretaries. The new Society would bring together bacteriologists, mycologists, protozoalogists, and bio-chemists who had long been working independent of each other, without any co-ordination or opportunity for discussion on common problems. The study of the fundamental aspects of bacteria, viruses, micro-fungi, protozoa and microscopic algae, such as their physiology, nutrition, chemotherapy, systematics and ecology, will be the primary concern of the Society.

The recent decision of the Colonial Office (*Nature*) to set up a Colonial Micro-biological Research Institute in Trinidad, for the general study of micro-biological problems in tropical condition, is another notable announcement concerning the future of micro-biological research. The Colonial Development and Welfare Act, 1940 will provide funds with which to finance the Institute whose general supervision has been entrusted to the Colonial Products Research Council. Dr A. C. Thaysen, the first Director of the Institute, is a well known micro-biologist and worked in the Chemical Research Laboratory of the Department of Scientific and Industrial Research. His fundamental investigations on food yeast have led to the development of a food yeast factory at Jamaica, now under construction.

SCIENCE AND CRIME IN INDIA

WHILE speaking on the subject of "Scientific Investigation of Crime in India" at a recent meeting of the Royal Asiatic Society of Bengal, Sir Douglas Gordon, a former Inspector-General of Police, Bengal, referred to Bengal's notable contribution to the scientific methods in the detection of crime. The first finger-print bureau in the world was started in Bengal at the end of the last century, and the formula forming the universal basis for classifying finger prints was devised after months of patient research

by two officers of the Bengal C. I. D., Mr Hem Chandra Sen and Khan Bahadur Azizul Haque.

This system of classification was transmitted to London in 1903, whence it spread throughout Europe and was adopted by almost all the police forces throughout the world. The principle that no two finger impressions are identical was known in China some centuries ago; but the Indian workers first realized its practical value and were able to tabulate and classify impressions in such a way that comparison was not only possible but also comparatively simple.

Modern researches reveal that impressions of finger, palmar and foot prints play a very important role in criminal investigation and are now employed in all progressive countries of the world. Investigation on finger, palmar and foot print is, therefore, essential for tracing criminals. Researches on these important aspects of criminal investigation are being carried on in the Anthropological Department of the University of Calcutta by Dr P. C. Biswas who worked on these problems under Prof. Geipel, one of the greatest authorities on this subject in the world. Dr Biswas lays particular stress on the importance of palmar prints in criminal investigation for obvious reasons.

Chance impression of the palm of hands are often found at the scene of crime. Impression of palm sometimes occurs singly without the finger print or may be accompanied with finger prints. Finger prints sometimes may not lead to definite identification of criminals. In such cases the impression of palm with or without the finger prints must be used for correct determination of criminals. The palm impression of the criminal, on his arrest, should also be taken with a view to comparing with the print obtained from the scene of action. If, however, the perpetrator is unknown, a thorough search in the palmar register should be made in order to compare the record of the palmar print provided such a register is available. Importance of maintaining a register for the palmar print similar to that for finger print need not be over emphasized. In Europe and America, the importance of palmar print has long been realized, and it is high time that all aspects of dactyloscopic criminal enquiry should be undertaken in this country as early as possible.

It is keenly felt that the Government should pay attention to this important aspect of dermatographic evidence in the investigation of criminals Complete record of palmar print of criminals of each district will facilitate correct and easy identification of criminals. In addition, provision for facilities of training and research in the scientific aspect of criminology should command the attention of the Government and the Universities in India.

SIR JOSEPH BANKS' LETTERS

A LARGE collection of 160-year old letters, largely written by Sir Joseph Banks, an eminent botanist and for many years President of the Royal Society, dealing with the East India Company's foundation of the Royal Botanic Garden in Calcutta, were recently presented to the Royal Asiatic Society of Bengal by H. E. Mr. R. G. Casey, Governor of Bengal. The letters came into the Royal Society's possession and were handed over to Prof. M. N. Saha, F.R.S. in November last, when the latter visited the U. K., the U. S. A. and Canada.

Sir Joseph Banks was the professor of botany at Glasgow and later his services were requisitioned by King George III as his botanical adviser. He held charge of the Kew Gardens, then a private garden, from 1780-1820. During this period, expeditions with botanical collectors, who were men trained at Kew, were sent to Australia, South Africa, South America, the West Indies, China, India and other parts of the world. Sir Joseph was himself a companion of Capt. Cook on many of his famous voyages and prominently identified with early Australia. The contact established by Sir Joseph between Kew and other colonies is continuing even in the present day. Kew Gardens is largely enriched with the herbarium specimens, which were the private property of Sir Joseph, and since Kew had no herbarium of its own, Sir Joseph, on his death, bequethed them to the British Museum.

Sir Joseph Banks was the recipient of 19 volumes of Koenig's manuscripts of description of Indian plants, on the latter's death in 1785. Koenig considered Sir Joseph to be the most eligible person to possess his papers and made a will bequeathing his manuscripts and herbarium to Sir Joseph. After Koenig's death, "Plants of the Coast of Coromandel" was published under the direction of Sir Joseph Banks in 1795. Koenig's herbarium ultimately reached the British Museum in London.

John Gerard Koenig, a pupil of Linnaeus, came to India in 1768 as a physician to the Danish Settlement in the Carnatic. Later he was in the service of Nabob of Arcot and ultimately served under the Company since 1780.

These letters are of interest to India as well as Australia and will throw a flood of new light on the history of the foundation of the Sibpur Botanic Garden by Col. Robert Kyd in 1787.

IT MIGHT HAVE BEEN BANKSIA

EMILY SNYDER writing in *The Scientific Monthly*, June 1945 gives an account of Sir Joseph Banks' interest in the collection and study of plants. His interest in plants was so great that Linnaeus wished to honour Sir Joseph by naming *Banksia* for

the continent Australia but for some reason the name was not favoured.

Banks sailed with Cook on the 29th April, 1770 and landed at a place that was christened by Banks as Botany Bay (near Sydney), because of the enormous number of strange plants he saw there.

BOTANIST FOR INDIA AT KEW

DR DEBABRATA CHATTERJI, M.Sc., Ph.D. (Edin.), F.L.S. (Lond.), has been appointed by the Government of India to the post of Assistant for India at the Royal Botanic Gardens, Kew, Surrey, England.

Dr Chatterji had a brilliant academic career. Graduating in science with First Class Honours in Botany in 1932, he was awarded the Hindu College Foundation Scholarship for post-graduate studies in the Presidency College, Calcutta. He also obtained a First Class Master's degree in Botany of the Calcutta University in 1934. After a short period of service as a lecturer in Botany at Vidyasagar College, Calcutta, Dr Chatterji joined the Edinburgh University in 1937, where he was a research student under Sir William Wright Smith, Kt., F.R.S., distinguished for his contributions to the taxonomy of Angiosperms and an authority in Eastern Asiatic Botany. He submitted a thesis on "the Endemic Flora of India and Burma" for his doctorate (published in the *Jour. & Proc. Royal Asiatic Society of Bengal*) and in this connection he had also to work at the Kew Gardens and the British Museum in London.

Returning to India in 1939, Dr Chatterji took up the post of lecturer in Botany at the Agricultural College, Mandalay (Burma). He was forced to evacuate in March 1942 and from April 1942 he served as a Systematic Botanist in the Botanical Survey, Government of India, for about a year. Since July 1943, he has been a lecturer at Cotton College, Gauhati, Assam.

The Government of India has since 1882, at the instance of Sir J. D. Hooker, maintained a liasion officer (assistant for India) at Kew to deal with the many questions referred to Kew from India on matters of systematic or economic botany. This official has in recent years often been a retired official, whose services were not available in India after the termination of period of his appointment at Kew.

During the course of a discussion regarding the appointment of a liasion officer from dominions (*e.g.*, Canada and Australia) at the Imperial Botanical Conference held in London in 1935, Prof. S. P. Agharkar, Ghosh Professor of Botany, Calcutta University, suggested that the time was ripe for India to follow the example set by the Union of South Africa and to send one of her University graduates, well-trained in systematic botany, to serve as the assistant for India for a period of two or three years, working through our Indian collections. On his return to India, the assistant richly stored with fresh knowledge and experience would be replaced by a successor to carry on his work for the benefit of the study of systematic botany in India. This would result in increasing the number of trained systematists in India having a personal knowledge of the collections at Kew and elsewhere.

This proposal was ultimately approved by the Government of India and the late Sir Arthur Hill, Director of the Kew Gardens, and in 1939 Mr K. N. Kaul of the Lucknow University was the first Indian appointed an assistant for India at Kew. Mr Kaul returned to India at the end of 1944 and will now be succeeded by Dr Chatterji.

We congratulate Dr Chatterji on his selection to the post and wish him a successful career at Kew.

UNIVERSITY OF BOMBAY

Department of Technology:—This Department has been thriving rapidly. Students are prepared in it for the degrees of B.Sc. (Tech.), M.Sc. (Tech.) and Ph.D.

An endowment of Rs. 1 lakh was received from the Trustees of the Estate of the late Rao Bahadur P. K. Kotawala for starting and maintaining a Department of Paints, Varnishes and Plastics.

Another endowment of Rs. 7 lakhs was received from Sir Homi Mehta for developing the Department of Technology by instituting Readerships in Plastics, Paints, Varnishes and Oils, Fats and Soaps, and for equipping the Departments of Foods and Drugs and Oils, Fats and Soaps.

An annual grant of from Rs. 16,000 to 23,000 has been promised by the Council of Scientific and Industrial Research, Delhi, for the establishment of a Department of Dyestuff Technology.

A new degree of Bachelor of Pharmaceutics has been instituted but the courses have not yet begun, due, perhaps, to the difficulties of securing materials during the war time.

Indian School of Physics:—A new School of Physics has been inaugurated by the Tatas in Bombay under the directorship of Dr H. J. Bhabha, F.R.S. from the beginning of the new academic term.

Department of Military Studies:—This new Department, opened by His Excellency the Chancellor in September 1943, has been doing well so far. However very few of the candidates for the diploma have been found fit for the line, a good number of them having not displayed even the qualities required of a leader of men. Some of them have, however, obtained the War Certificate "A" required by the military authorities.

Diploma in Librarianship:—The first examination for this new diploma was held in March 1944. The staff of the University Library, headed by Dr Joshi, has been giving lectures along with other visiting lecturers.

Geography as a Science Subject:—The Bombay University has now recognized the value of Geography as a science by prescribing courses in this subject for the B.Sc. examination, after a struggle of about a decade against the orthodox members of the Academic Council, led by those interested in the future of Geography, especially Professor Pithawalla. The first examination in this subject for B.Sc. was held in March-April last.

Research work done:—The following are among the theses accepted or published by the University during the past year: Dr M. G. Bhagat—"The Farmer, his Welfare and Wealth"; Dr M. Ganju—"The Textile Industries in Kashmir"; Dr U. T. Thakur—"Sind Hindu Culture"; Dr R. M. Halder—"The Society and the Visually Handicapped"; Dr D. P. Khanapurkar—"The Aborigines of South Gujarat".

JOURNAL OF COLLOID SCIENCE

THE Academic Press Inc. of New York, U. S. A. will be soon publishing a *Journal of Colloid Science*, and the first issue of the journal is expected to come out in January, 1946. The following aspects of colloid science will be dealt with:

(*a*) Fundamentals: Physics, Physical Chemistry and Chemistry of Colloids and Surfaces.

(*b*) Applications: (1) Industry, *e.g.*, Plastics, Soaps, Photography, Food and Flotations, Emulsions; (2) Biology, Protoplasma, Cell-structure.

The journal is intended to have an international character and the following Editorial Board and Consulting Committee have been set up:

Editors: T. R. Bolam—Edinburgh, Scotland; E. F. Burton—Toronto, Canada; J. W. McBain—Stanford Univ., Calif.; F. K. Rideal—Cambridge, England; W. Seifriz—Philadelphia, Penna.; A. W. Thomas—New York, N. Y.; A. Tiselius—Upsala, Sweden; H. B. Weiser—Houston, Texas.

Consulting Committee: W. T. Astbury—Leeds; W. Clayton—Orpington, Kent, England; P. Debye—Ithaca, N. Y.; A. Frumkin—Moscow, U.S.S.R.; W. D. Harkins—Chicago, Ill.; Hans Jenny—Berkeley, Calif.; S. S. Kistler—Norton Co., Worcester, Mass.; J. N. Mukherjee—Calcutta, India; F. F. Nord, New York, N. Y.; The Svedberg—Upsala, Sweden.

Papers from India may be submitted to Professor J. N. Mukherjee, C.B.E., D.Sc, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

The Editors intend to maintain a high scientific standard.

ANNOUNCEMENT

WE are glad to announce that Dr G. Watts Padwick M.Sc., Ph.D. (Lond.), Government Mycologist, Bengal, Director, Research Laboratories, and Principal, Agricultural Institute, Dacca (formerly Imperial Mycologist, Government of India), has been admitted to the degree of doctor of science, London University, on the merits of his work on "Diseases of plants in India, Great Britain and Canada with special reference to *Fusarium* diseases, and taxonomic work on Indian Fungi."

We congratulate, Dr Padwick on his success.

SCIENCE IN INDUSTRY

SYNTHETIC SAPPHIRES

THE *Review of Scientific Instruments*, May 1945, reports the recent success attained in the United States in the production of synthetic sapphires, such as corundum and spinel. Corundum is a crystal of aluminium oxide and has remarkable physical, chemical and optical properties. It is next to diamond in hardness. On account of these properties it is chiefly used as a bearing material in precision instruments and mechanisms and also as a gage material. Its great hardness, long life, freedom from distortion and corrosion, and capability to retain high polish recommend its use as a highly suitable material for gages.

Corundum is synthesized by fusing aluminium oxide in an oxy-hydrogen flame and then depositing the fused material on a fine clay pedestal into a carrot-shaped mass known as a 'boule'. The boule is a single crystal with remarkable homogeneity and, on an average, weighs 200 carats, although 400-carat boules, about 3/4th inch in diameter and 2 inches in length, have been produced. Synthetic ruby can be prepared by adding chromium oxide to aluminium.

Recently, the Linde Air Products Company has succeeded in producing long crystals of rod corundum, having diameters ranging from 0·060 to 0·125 inch and length up to 30 inches. Special significance attaches to the preparation of rod corundum which is used for jewel bearings and which assures economies in labour and in critical materials such as diamond and copper used in the cutting saws.

Spinel is another mineral whose synthetic production on an experimental scale is reported. It is a combination of magnesium and aluminium oxides and is harder than steel, glass, or quartz, though less hard than sapphire. The process of synthesis is identical with that for sapphire. Spinel is also useful as a bearing material.

PLASTICS EYES

ARTIFICIAL glass eyes are known and have received wide application throughout the world. Before the war, Germany almost monopolized the manufacture of artificial glass eyes and such countries as the U. S. A., Britain and others had to depend largely on German supplies. The American Optical Company is recently reported (*Scientific American*) to have developed a new all plastics artificial eye superior to glass eyes in several respects.

The new artificial eye is moulded from non-irritating acrylic resin. The eye is made in three parts. The sclera, or the white portion of the eye, is moulded from a translucent plastics, into which a round recess is cut for the iris. The iris is a photographic reproduction of true iris, properly coloured and is fitted into the scleral recess. Finally, the sclera and the iris are covered by a transparent plastics. Three parts fuse excellently with one another, producing a single piece all plastics eye.

All plastics eye is non-irritating and more life-like than a glass eye. The life-like appearance is due to the photographic reproduction of the iris and the smaller reflection of light from the surface, unlike glass eyes. Plastics eyes are durable and can be reshaped by grinding to fit the eye socket comfortably. The eye socket secretions have no corrosive action on such eyes which can be retained during night.

RECLAMATION OF INSECT INFESTED FOODGRAINS AND FLOUR

INSECT infestation has always been a serious problem for the grower, the distributor and consumer of foodgrains and flour. During peace time, there is usually quick and liberal distribution of food materials with the result that losses through insect infestation are not acutely felt. During war time, however, owing to restricted food supply, a nation-wide system of rationing and the necessity for storing large quantities from one crop season to another, the problem has become fairly acute.

Improved methods of storage, as also the introduction of hygienic measures for collection and transport, will undoubtedly help to reduce the incidence of infestation, but they cannot altogether eliminate insect life unless some drastic treatment for the complete destruction of all the insects and their eggs is also adopted. Under Indian conditions, adoption of hygienic methods of collection and transport is not always practicable. Insect proofing of godowns will not altogether eliminate the multiplication of insects already present within the bags. Even in other countries where all kinds of precautions are taken before exporting, it is not altogether possible to eliminate insect infestation as may be seen from the condition of some of the foodgrains and flour imported into India during recent years.

Certain types of food materials attract insects to a greater extent than others. Thus, unpolished or underpolished rice which is a feature of the present day attracts more insects than polished rice because of the association of bran with it. Similarly,

whole wheat flour which is now distributed in large quantities and is also stored for fairly long periods attracts insects to a considerable extent. The problems of the present time are naturally more complicated than would have been the case in the pre-war period.

Insect infestation causes not only a certain amount of direct loss, but also a great deal more of indirect loss of food materials. The insects usually eat up only a small part of the solid matter of the food material (usually less than 5 per cent), but they produce a good deal of moisture and bad smell. They also leave their excreta and other residues which, though not usually poisonous, are not altogether desirable. The increased moisture content encourages fungus growth. Rancidity is also much favoured. As a result of these, the food materials, though still retaining a large part of the main food ingredients, are rendered unattractive and in many cases also unsuitable for use as human food.

Some preliminary observations made by us would suggest that the insects either use up or destroy a considerable part of the vitamins (particularly vitamin B_1) of the foodgrains and flour. This subject is under further systematic scientific study.

Insect infestation, combined with conditions of indifferent storage, has led to extensive spoilage of foodgrains and flour in different parts of the country. Some of the spoilt material develops foul smell and taste and, in that condition, it is unfit for human consumption. In good many cases, the spoilage is not so extensive, but it is very difficult to distinguish between different degrees of spoilage excepting on some arbitrary basis. In actual practice, some authorities are more severe than others. In certain areas, it is quite common to find certain types of heavily infested articles either sold openly in the market or distributed as rationed articles to the civil population ; whereas, in others, the same articles, possibly in an even better state of preservation, are condemned on a wholesale basis by the authorities. Purely scientific considerations do not always determine the acceptance or rejection of such food materials.

Neither insect infestation nor the resulting spoilage starts all at once. They take some time to develop and if a proper watch could be kept, it should be possible to put a stop to insect multiplication and the attedant spoilage at a fairly early stage. The foodgrains and flour thus treated should last for quite a considerable length of time. This type of control is not apparently exercised to the desired extent at all centres. The spoilage is usually noticed only at a rather late stage when reclamation is not so easy.

Speaking from the purely scientific angle, infested foodgrains and flour should be generally capable of treatment so as to render them suitable for human consumption. The insects and their eggs can be killed out. The webs formed by the insects can either be removed as such or broken up. The vegetative growth of fungi can be suppressed, and even most of their spores killed out. The moisture content can be reduced and further spoilage through this agency thus arrested. The smelly constituents can be either volatilized off or their odours neutralized. The bad taste that is noticed in some cases can also be eliminated. Even if these are not fully accomplished, it should still be possible to reclaim the foodgrains and flour to such an extent as to render them suitable for use in certain types of preparations which would automatically mask the slightly disagreeable taste and flavour. Thus, reclaimed *atta* which has got a smell and a somewhat bitter taste may not make good *chapatis* or certain types of preparations where boiling with water is involved. The same *atta* will be suitable for frying and baking operations. Mixed with other ingredients, the disagreeable flavour and taste can be completely eliminated.

In dealing with a problem of this type, there is one other aspect which would deserve very serious consideration. Over a large part of India, the majority of the population can hardly afford two meals a day. A food material which still retains the major part of its feeding value should any day be more valuable than none at all. The reclaimed foodgrains and flour, even if slightly smelly, should still be acceptable to a large section of people in the country.

Over a large part of the country, storage of foodgrains and flour is being done under the supervision of entomologists who also attend to the periodical examination of the materials, de-infestation of godowns and so forth. The entomological strength is not, however, sufficient to keep continued watch and to control infestation in every part of the country and in every store and godown. In good many cases, the infestation increases during the period of storage and when the grains or flour are finally examined, the spoilage is often in an advanced stage.

What we need very badly at the present time is not only more efficient check on materials in storage but also the adoption of quick and drastic methods to kill out the insects and to arrest the attendant spoilage as soon as it is detected. There should also be a certain amount of technical control to determine the extent of spoilage at any particular stage. Skilled staff will also be needed to handle materials showing a certain amount of spoilage and to reclaim them quickly before they become more or less unfit for human consumption.

It becomes increasingly necessary, therefore, that in addition to further entomological control,

there should also be a nucleus of special staff whose constant endeavour will be to take over the partially spoilt grains and flour and to reclaim them as soon as possible. Some methods of reclamation are already known. Further methods have also to be studied particularly in regard to the removal of undesirable smell and taste. This type of work would require the whole time attention of a competent biochemical staff.

It is earnestly hoped that in consideration of the importance of the problem, very early steps will be taken by the Government to build up a nucleus of technical staff whose concern will be (1) reclamation of infested foodgrains and flour by known methods and (2) development of new and improved methods for the reclamation of foodgrains and flour. It may not be possible for the same people to do both research and routine work. This could be easily organized by appointing different staff for the two types of work. Once a nucleus could be built up, more trained personnel could be produced and these could go out to different parts of the country and assist the various Provinces as well as the States in reclaiming the food materials wherever there is a suggestion of spoilage.

C. N. Bhima Rao
V. Subrahmanyan

THE MENISCUS TELESCOPE

A new type of telescope, using a concave meniscus lens and combining most of the good qualities of both reflectors and refractors, has been recently developed by Dr D. D. Maksutov, of the State Optical Institute, according to a note by Mr G. Stanley Smith in *Nature*, June 30, 1945. The detailed description of the principle and the advances of the new telescope originally appeared in the Russian journal *Nauka i Zhizn* (*Science and Life*).

The new telescope works on a very simple principle which may be clearly appreciated with reference to the accompanying diagramme (Fig. 1) reproduced from *Nature*. B is a thick concave meniscus lens with exceedingly small power and is placed in front of a concave spherical mirror A. The concave mirror may be silvered or aluminized and has a small opening at its centre. The central part C of the meniscus B is also silvered. Parallel rays from the distant object are incident on the concave side of the lens and emerge almost as a parallel beam (more correctly, as a slightly divergent beam) to be reflected successively at A and C to form the image at F_1.

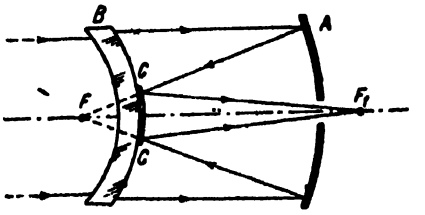


FIG. 1

The system, known as the meniscus catadioptric system, is remarkably free from defects in the images due to spherical and chromatic aberrations. The elimination of spherical aberration in this system is of particular interest and rests on the fact that, whereas the meniscus lens produces positive aberration, the concave mirror gives rise to negative spherical aberration. Dr Maksutov has shown that proper selection of the radii of curvature of the meniscus and mirror, the thickness of the meniscus and of the quality of glass employed permits of complete elimination of this defect. The removal of the chromatic defect is also reported to be very satisfactory in this arrangement. The meniscus telescope combines the compactness of a refractor with the achromatism of a reflector.

Mr Smith reports that the meniscus telescope is capable of better definition and sharpness of image than is possible with the Yerkes refractor having a tube length of 20m. or with the Simeiz reflector (now destroyed) having a parabolic mirror of 1m. diameter and a tube length of 5m. Besides reduction in size which is itself a great advantage, meniscus telescope is much cheaper than the Simeiz or the Yerkes type. The cost of 1m. aperture Simeiz and Yerkes telescope has been estimated to be respectively four times and seventy times the expenditure involved in making a meniscus telescope of similar aperture. The high efficiency and low cost of the new type of telescope may lead to its great demand in the post-war period when rehabilitation of observatories already destroyed and construction of new ones are to be undertaken in right earnest.

S. N. S.

A SUBMARINE CABLE FAULT

MONORANJAN DATTA

THE supply of energy by the Narayanganj Electric Supply Company on the eastern side of the river Sitalaksha was completely cut off by the break-down of a submarine cable linking up the power house on one side of the river with the sub-station on the other. The cable consisted of a three-core (7/16) 0.0225 sq. in. conductors insulated with impregnated paper, lead-sheathed and jute-served over all and double wire armoured. It was laid in the river bed; the route length was 800 yds., and there was only one joint on the power house side connecting it to the underground cable. The resistance of each core of the cable per 1000 yds. is 1·116 ohms.

In an attempt to localize the fault, it is necessary first to know the nature of the fault concerned, in as much as the tests to be carried out depend to a large extent upon the nature of the break-down. The tests were done primarily in respect of the general insulation to earth and to core, and of the continuity of the conductors.

The insulation resistance of all conductors was tested each way, *i.e.* once from the power house end and again from the sub-station end with a 500 volts megger. The results from the power house end showed the insulation resistance to be right down to earth, but those from the sub-station end gave higher readings.

The cores of the cable were all separately coloured. The continuity tests were carried out first with the help of a bell and a battery, and then with a test lamp and 230 volts A.C. supply pressure. These tests were applied with all the ends of the cable at the sub-station end shortened together and earthed, and again with the earth removed.

With the bell and the battery the result was no ring in all cases and with the test lamp the results may be stated as below:

With the red core and the sheath connected together, the lamp glow was feeble.

With the blue core and the sheath connected together, the lamp glow was feeble.

With the yellow core and the sheath connected together, the lamp glow was full.

When the same test was applied to the cores, the following results were observed:

With the red and the blue connected together the glow was feeble.

With the red and the yellow connected together the glow was full.

With the blue and the yellow connected together the glow was full.

With the earth removed from the sub-station end, the glow of the lamp in the case of the yellow core was full, in the case of the red core feeble, and in the case of the blue core very feeble.

The insulation and the continuity tests thus completed, the insulation resistances between main conductors were measured by (*a*) a megger and then verified by (*b*) a bridge megger. These measurements were carried out from each end. The measured resistances are given below:

Conductors need for tests.	Measured Resistances in ohms. With loop at the remote end of the sub-station end	Result from power house end the sub-station end open circuited.	Result from sub-station end the power house end open circuited.
Red—sheath		1,540	17,000
Blue—sheath		2,640	15,000
Yellow sheath		1·4	18,000
Red blue	4,000	5,000	12,000; 20,000
Blue yellow	4,500	4,400	2,000; 2,000
Red yellow	2,660	3,500	12,000; 25,000

The figures in the fourth column of the last three rows indicate that the resistances were measured twice in each case with an interval between each measurement.

It will be seen that the results in the case of Blue-Yellow and of Red-Blue indicate that there would be a comparatively high resistance break in the conductors concerned more than in the case of Red-Yellow, as the resistances for completed loops in the first cases approximate to those under open circuit condition. In each case, however, the resistance of the completed loop is greatly in excess of the calculated resistance of the two conductors in series, *viz.* $2R = 1·79$ ohms. When the resistances were measured from the sub-station end with the power house end open circuited, the resistances in cases of Red-Blue and Red-Yellow appear to be considerably greater and varying. Evidently it is the red conductor which has more or less a complete break. Moreover, the resistances between each of the cores and sheath show that the dielectric of the yellow core has deteriorated so as to result in a low resistance fault to the sheath. The fault can be represented diagramatically as in Figure 1.

It would, therefore, appear from the results that in the present case an earth fault has deve-

loped on one of the cores, though the insulation between the cores has not broken down completely.

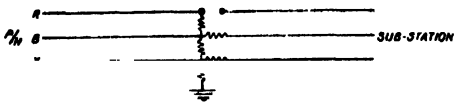


FIG. 1

Each of the cores again appears to have 'breaks' in the nature of a high resistance or partial contact. This was confirmed in the following way :

An independent return cable composed of 5 coils 3/20 V.I.R. and 4 coils 3/22 V.I.R. was run across the river, the total mean resistance of the cable being the mean of three measured values, *viz.* 9·55, 9·0, and 9·2 ohms, *i.e.* 9·25 ohms.

The resistance of each core of the cable through the common return was measured by the bridge megger and the following results obtained :

Red	--Common return	23,990 ohms.
Blue	- Common return	3,980 ohms.
Yellow	--Common return	2,045 ohms.

moreover, the resistance of the lead-sheath through the common return was found to be of the order of 50 ohms.

In view of the partial 'breaks' in the cores of the conductors and also in the lead sheath, the usual low resistance fault localization tests, *i.e.* the bridge test or the fall of potential tests were not considered.

Figure 2 shows a modified potential fall test which was applied to the faulty core (*viz.* the yellow core) using the common return or the pilot wire as it is called for the verification of the continuity test.

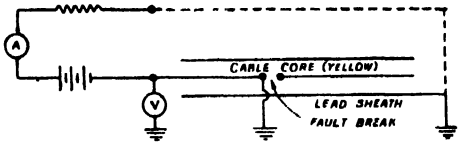


FIG. 2

A 6-volt battery was used to drive a steady current through the fault to earth *via* the return loop set up. If V be the voltmeter reading to earth at the near end of the faulty cable with a current I flowing, then

$$\frac{V}{I} = x + f$$

where x = resistance of the conductor from the power house end to the fault, and f = fault resistance to earth from power house end to earth, the two being in series.

It, therefore, follows that knowing the value of f, the value of x can be found out from the readings of the voltmeter and the ammeter. The actual fault position at a distance F from the power house end is a proportion of the total length (800 yds.) in the ratio of $x : R$; therefore,

$$F = \frac{x}{R} \times 800 \text{ yds.}$$

The calculated resistance R for a length 800 yds. of the cable conductor used was 0·89 ohms.

In the test carried out in accordance with the diagramatic plan given above, the following readings were noted by the ammeter and the voltmeter.

I in m.a.	V in m.v.
99	28·2 × 12
85·3	25·2 × 12
57	20 × 12
89·5	26·3 × 12

Carrying out the third readings, we get V/I = 3·4 ohms (approximately).

The earth resistance of the yellow phase at the fault was measured to be 2·2 ohms and that of the lead-sheath ·6 ohm, so that f comes out to be 2·8 ohms, when x becomes equal to ·6 ohms.* But these results are not of much value as to the location of the fault. For full investigation, therefore, further tests are to be carried out, which could not be done this time for want of time.

However, an examination of the investigation carried out so far suggests the following :—

(1) The break in the conductor is confirmed. The strands of each of the core are severed. It is likely that when a fault occurs, and the current available at the fault—specially if the switch action delayed is too large, the cable cores may have reduced in cross sectional area by the resultant arcing with the consequent sequel that the strands are left open circuited.

(2) Even if the strands were not all completely severed a small reduction in the area of the core can prevent the loop or the drop tests from locating the fault as the current will travel over a considerable distance before the current is again shared equally amongst all the conductors. Its effect is similar to that of an addition of a resistance at that point, equivalent to the many yards of length of the cable core.

(3) In the case of the yellow core all the strands do not make contact with the lead sheath ; contact is more likely to be made by one or more of the strands lying on one side (*viz.* power house end) of the damaged place. The 'earthed' strand is not neces-

* An extract of a letter when in press from the Chittagong Engineering & Electric Supply Co. Ltd. (Narayanganj Branch) will be of interest.

"The defect located in the submarine cables within 600 ft. from the sub-station end. The cause of the defect is due to unauthorized anchorage. The submarine cable is twisted in one place swerving the armouring."

sarily in intimate contact with its neighbours ; it also might carry the test current sent to it *via* the earth up to a considerable distance before the remaining strands share it equally. This alone has the effect of shifting the earth point electrically from the actual fault position to some remote and quite indefinite place. This is also equivalent to the addition of a new resistance to that of the cable core.

The above fault might have been caused by a large anchoring accidentally at or near the place where the cable was laid, causing damage to the protecting sheath directly through mechanical force or it might have been the result of corrosion of the lead sheath followed by the penetration of moisture and consequent break-down. In either case it is probable that the ultimate break-down was caused by the gradual penetration of moisture.

In order to make sure that there will be no recurrence of the same damage in future, it is necessary in the first place to trace the cause ; no fault should be allowed to pass unexamined. The damaged cable should be taken up and data collected concerning its previous history. It will then be possible to ascertain whether the damage is due to external agencies or due to corrosion. If this be definitely known requisite precaution against future break-down can be planned out.

Corrosion may be either chemical or electrolytic. The electrolytic corrosion of buried metallic structure is caused by currents originating from a number of causes, of which the following may be cited :

(*a*) D. C. supply system,
(*b*) Natural earth currents,
(*c*) Galvanic currents
(*d*) Electric traction systems.

In this case if the fault is at all due to electrolytic corrosion it is the cause (*c*) which seems to be involved. It is due to contact of dissimilar substances ; the production of such current is accelerated by the presence of electrolytic solution. These happenings may not be uncommon in the case of a submarine cable.

MEDICINE AND PUBLIC HEALTH

MEDICINAL PRODUCTS FROM ORISSA

THE report of the "Industrial Survey of Orissa" by H. B. Mohanty (1945) states that the cultivation of cinchona plants is being tried in the Jeypore Estate in the district of Koraput, and something like a thousand trees have been planted as an experimental measure. The Forest Department of the estate is trying to increase the area under plantation. By the older process the plants were allowed over five years to mature before extraction of quinine from their barks could be taken up. The new Russian experiment of extracting quinine from one year old cinchona trees ought to be given a trial as India's requirement of quinine is very much greater than the present production. Considering the wide prevalence of malaria, and its injurious effects upon the people, the question of increasing the production of quinine is an urgent one. If the experiment of growing cinchona trees in the Koraput district proves to be a success, it might be possible for the Province to get all the quinine she needs within her own boundaries.

It is also desirable to set up the necessary plant to extract strychnine from the seeds of nux-vomica which grows abundantly in many parts of Orissa, and the neighbouring States. All the nux-vomica now grown in Orissa and in Orissa States are exported.

The Fisheries Department of the Government of Orissa, prepared last year more than 100 gallons of shark liver oil from the sharks caught off the Orissa coast and found that it would be possible to prepare the oil on a commercial scale and market the product at a reasonable price to compete with cod liver oil. It is now left to the business organizations to develop the industry on a commercial scale. When the industry develops, further benefits will accrue by utilizing the by-products such as shark skins and flesh. Shark skin yields fine soft leather and shark flesh could be utilized for manufacturing fish glue.

No attempt has been made to extract the active principle found in *Vitex peduncularis, Cassia berina and fistula, Andrographis paniculata, Adhatoda vasica, Saraca indica, Datura fastuora* etc., for medicinal use. These plants grow wild and in abundance in Orissa. When a chemical and pharmaceutical industry is started in Orissa, the innumerable herbs, and medicinal plants found in plenty in Orissa will

provide valuable raw materials for preparing syrups, alcoholic extracts, and tinctures, etc.

ERGOT PRODUCTION IN THE TROPICAL PLAINS OF BENGAL

ERGOTS are hard, bluish-black structures formed as a result of development of the ergot fungus (*Claviceps purpurea*), on the heads of certain cereals and grasses, where the ovaries of the individual flowers so affected become malformed, and ultimately produce the ergot of commerce. Poisonous alkaloids obtained from these bodies are used for in obstetrics, in the control of internal haemorrhage, in spinal and cerebral congestions, in periodic sick headache, known as migraine, and in the recent war it has been successfully used in the treatment of wounded soldiers and air raid victims.

It has been estimated that British requirements amount to 50 tons per annum and the principal sources of supply prior to the war were Spain, Portugal, Russia, Poland and the Baltic States, where natural infections are common from year to year.

Because of this dependence on foreign supply, Britain and its dependent countries experienced a 'ergot famine' during these war years. The British Ministry of Health in 1941, made an appeal to take up researches for its production under artificial conditions. Following this, investigations for its cultivation in Wales and W. coast of England achieved some success. Australia attempted its production in New South Wales and Victoria and achieved more success in the latter place. In India, the Madras Government is financing a scheme for its cultivation in the Nilgiri hills at an altitude of 6,000 ft. during the winter months, where its cultivation has been a success (*Madras Agricultural Journal, 30*, December, 1942).

Indigenous ergot, as well as those artificially produced have so far been found to grow only in temperate climates and at an altitude of 4,000 to 6,000 ft. With a view to acclimatize and make the rye plants grow under such tropical conditions as in Calcutta, investigations were undertaken by Mr J. C. Saha of the Botany department, Presidency College, Calcutta. With proper care and manipulations the rye plants (*Secale cereale*) were found to make a luxuriant growth in the botanical garden of the college. And when the rye were in blossom the flowers were artificially inoculated with the spores of ergot fungus. The flowers got readily infected, and in about 3 months a good produce of ergot sclerotia was obtained. The sclerotia were analysed according to B. P. Addendum, 1943, and found to contain a total alkaloid content of 0·32% against the B. P. standard of 0·2% and the Ergometrine content of 0·07% against the B. P. standard of 0·03%. So it appears that high quality ergot, could be produced in this country.

This is the first record of ergot production under any tropical conditions or in the plains. The results establish the fact that ergot if commercially produced in this country, can not only meet the total demand of India but also can be exported outside, because of its cheap labour.

ON UREA STIBAMINE

S. DATTA, T. N. GHOSH and A. N. BOSE,

BENGAL IMMUNITY RESEARCH LABORATORY, CALCUTTA

INTRODUCTION

UREA STIBAMINE, introduced in India by Brahmachari[1] in 1922 as a specific drug for the treatment of Kala-azar, is formed by the interaction of urea with *p*-aminophenylstibinic acid. Regarded at first as a simple urea salt, it was later thought to be ammonium salt of 4-carbamidophenyl-stibinic acid, NH_2-CO-NH-C_6H_4-Sb.O_3H (NH_4), a substance which has been synthesised by Niyogi.[2] Subsequently, the detailed researches of Gray, Trevan, Bainbridge and Atwood[3] indicate that Urea Stibamine is a complex mixture containing not only the monocarbamide but also *S*-diphenylcarbamido-4 : 4′-distibinic acid, (H_2O_3Sb-C_6H_4-NH-)$_2$CO, which they have synthesised by the phosgenation of *p*-aminophenylstibinic acid. They consider that *p*-aminophenylstibinic acid normally employed in the preparation of Urea Stibamine apparently contains varying quantities of its acetyl derivative. When heated with urea, such impure specimens of stibanilic acid partly react with the urea forming the above distibinic acid and partly undergo hydrolytic fission with the production of antimonic acid. In the pure state the above distibinic acid does not form salts with any appreciable solubility in water. When antimonic and *p*-acetamidophenylstibinic acids, however, are present, as in Urea Stibamine, its solubility is increased owing to the action of these substances as protective colloids. The

[1] Brahmachari, U. N., *Ind J. Med. Res., 10*, 508, 1922; *13*, 111, 1925.
[2] Niyogi, S., *J. Ind. Chem. Soc., 5*, 753, 1928.
[3] Gray, *et al*, *Proc. Roy. Soc., 108B*, 54, 1931; *J. Chem. Soc., 128*, 3181, 1926.

reaction between urea and *p*-aminophenylstibinic acid proceeds mainly according to the following course:

(1) $NH_2\text{-}CO\text{-}NH_2 + 2NH_2\text{-}C_6H_4\text{-}SbO_3H_2 \longrightarrow (H_2O_3Sb\text{-}C_6H_4\text{-}NH\text{-})_2CO + 2NH_3$

(2) $NH_2\text{-}CO\text{-}NH_2 + NH_2\text{-}C_6H_4\text{-}SbO_3H_2 \longrightarrow NH_2\text{-}CO\text{-}NH\text{-}C_6H_4\text{-}SbO_3H_2 + NH_3$

(3) $H_2O + NH_2\text{-}C_6H_4\text{-}SbO_3H_2 \longrightarrow C_6H_5NH_2 + H_3SbO_4$

According to Gray *et al.*, the therapeutic activity of Urea Stibamine is largely due to *S*-diphenylcarbamido-4:4′-distibinic acid. In this connection it may be remarked that these authors have not been able to separate the different chemical constituents present in this drug in pure forms but have indicated the above course of reaction between urea and *p*-aminophenylstibinic acid on the basis of a good number of experiments and analyses.

Although Urea Stibamine has two drawbacks, namely, its variable constitution and its instability, it is a very potent drug for the treatment of Kala-azar. However, this drug at times does show toxic reactions and it is sometimes observed that one lot is more toxic than another, although the antimony content of the former may be less than that of the latter. Evidently, therefore, the toxicity of this drug does not always depend on its total antimony content. In view of the great importance of this drug in the chemotherapy of Kala-azar, it has been thought of considerable importance to make a further detailed examination of various samples of this drug with a view to ascertain the factors that control its toxicity and therapeutic potency, so that a standard as to the limit of antimony content, toxicity and therapeutic potency can be found out.

Experimental Observations and Conclusions

Several samples of the drug, prepared in this laboratory, have been analysed and pharmacologically examined. Some chemical characteristics observed and the toxicity of a few typical samples are recorded below, which would throw some light on the constitution of the drug in its relation to toxicity.

(1) *Absence of aromatic amine in Urea Stibamine*: Contrary to the observation of Das Gupta,[1] Urea Stibamine is not found to give a diazo-reaction. To an ice-cooled aqueous solution of the drug, excess of ice-cold $\frac{N}{4}$ hydrochloric acid is added and the precipitate formed is filtered. The filtrate, containing excess of hydrochloric acid, does not give diazo-reaction. Moreover, if the above precipitate is not filtered, the cold mixture containing excess of hydrochloric acid does not also give diazo-reaction. This shows that Urea Stibamine does not contain any aromatic amine like *p*-aminophenylstibinic acid.

[1] Das Gupta, J. M., *J. Ind. Chem. Soc.*, *10*, 174, 1933.

When an aqueous solution of Urea Stibamine is allowed to stand at ordinary temperature, the solution remains clear, and, even after 3-4 hours, the solution, on acidification with $\frac{N}{4}$ hydrochloric acid at 0°, does not give any diazo-reaction. If, however, an aqueous solution of the drug is allowed to stand for 24 hours or so, the solution under the above conditions responds to diazo-reaction. It is, therefore, evident that the drug on prolonged exposure to moisture may give rise to an aromatic amine like *p*-aminophenylstibinic acid or aniline, both of which are, as such, toxic substances.

(2) *Influence of free, uncombined Urea in Urea Stibamine on the toxicity of the drug. Presence of ammonium radical in the drug.*

It is found that Urea Stibamine contains some amount of free, uncombined urea, which is completely removed by triturating and washing the well-powdered drug with hot absolute alcohol several times. It has been found that the presence of free, uncombined urea, however small in quantity, lowers the toxicity of the drug. After complete removal of free urea, the toxicity of the drug is increased, even though the intravenous toxicity dosage (in terms of total antimony content) is kept the same.

After complete removal of free urea by trituration and washing with hot alcohol several times, the solid is found to be readily soluble in water. But, if this solid, thus treated, is thoroughly triturated with excess of cold, normal hydrochloric acid, filtered and washed with cold, absolute alcohol to remove the last trace of hydrochloric acid, it is found to be insoluble in water. The analytical data indicate that the compound has lost further nitrogen, and the examination of the acid filtrate shows that this loss in nitrogen is due to the elimination of ammonia. Thus it is indicated that the drug contains some ammonium salt and when the ammonium radical is replaced by hydrogen by treatment with hydrochloric acid, the resulting solid becomes insoluble in water. So, the solubility of the drug in water is mainly attributed to the presence of this ammonium salt, though present in small quantity.

The above results are represented in the following table (No. 1):

(3) *Antimony content in relation to Toxicity*: Gray *et al.* (*loc. cit.*) visualised the formation of antimonious acid, besides antimonic acid, during the condensation of *p*-aminophenylstibinic acid with urea, but they did not estimate the content of antimonious acid or antimonic acid present in the various samples of the drug analysed by them. In order to see if the presence of these acids has any influence on the toxicity of the drug, the antimony contents (in various stages, such as, inorganic state or in organic combination, trivalent or pentavalent) of some samples

of the drug prepared in this laboratory have been estimated. It has been found that Urea Stibamine does contain some antimony in the trivalent stage (possibly present as antimonious acid) and some in pentavalent stage (possibly present as antimonic acid), and the presence of these acids appears to have some influence on the toxicity of the drug. The greater the quantities of these acids, the more is the toxicity of the drug generated. Thus, it appears that the toxicity of the drug does not solely depend on the total antimony content but depends a good deal on the amount of antimonious and antimonic acids present in the drug. This observation explains why one sample of the drug is sometimes found more toxic than another, although the total antimony content of the former may be less than that of the latter. The experimental conditions employed for the condensation of *p*-aminophenylstibinic acid with urea indicate that the quantity of antimonious and antimonic acids formed is mainly conditioned by the temperature employed for the above condensation. It is indicated that, higher the temperature employed, more is the quantity of these acids formed.

The above result, obtained with some typical samples of the drug prepared in this laboratory, is represented in the following Table (No. II).

TABLE I

UREA STIBAMINE (SAMPLE A)
(dried at ordinary temperature over fused calcium chloride *in vacuo* till weight is constant)

Treatment	Nitrogen (Dumas)	Total antimony (Gray)	*p*H (2% aqueous solution)	Solubility in water; aspect of the solution	Intravenous toxicity test on mice	
					Dose	Mortality
Freshly prepared and dried ..	17·42%	41·5 %	6·0	Good; clear	225 mg/kg.	1/10
Trituration and washing with hot, absolute alcohol twice	5·14%	45 14%	7·04	Good; clear	225 mg/kg. 200 mg/kg.	4/10 3/10
Further trituration and washing with hot absolute alcohol twice	5·13%	45·14%	7·04	Good; clear	200 mg/kg.	4/10
Trituration with cold normal Hcl	3 87%	45·4 %	—	Insoluble in water	—	—

Total antimony content of the samples has been estimated according to the method of Gray, a blank experiment having been done in each case. Total pentavalent antimony has been estimated following Gray's method, without, however, using any potassium permanganate. Trivalent antimony content (possibly present as antimonious acid) has been determined by the usual method of oxidation with iodine in presence of sodium potassium tartrate and excess of sodium bicarbonate. Pentavalent antimony content (possibly present as antimonic acid) has been determined by adding excess of cold normal sulphuric acid to an ice-cooled aqueous solution of the sample, and then adding urea (1·5 gm. for 0·5 gm. of the sample). Potassium iodide is then subsequently added and the liberated iodine is then estimated by the usual method. A blank experiment has been carried out in each case.

SUMMARY

(*a*) Urea Stibamine does not contain any free aromatic amine but on prolonged exposure to moisture, may give rise to an aromatic amine like *p*-aminophenylstibinic acid or aniline, both of which are, as such, toxic substances.

TABLE II

UREA STIBAMINE

Sample	Total antimony	Total pentavalent antimony	Trivalent antimony (present as antimonious acid)	Pentavalent antimony (present as antimonic acid)	Intravenous toxicity on mice	
					Dose	Mortality
A	41·5%	39·62%	1·83%	1·2%	225 mg/kg.	1/10
B	40·3%	38·8 %	1·7 %	1·1%	225 mg/kg.	2/10
C	36·0%	33·1 %	2·86%	1·6%	225 mg/kg.	4/10
D	39·7%	37·2 %	2·7 %	1·5%	225 mg/kg.	4/10

(*b*). The presence of free, uncombined urea in Urea Stibamine appears to help in lowering the toxicity of the drug. The drug appears to contain some ammonium salt and the replacement of the ammonium radical by hydrogen renders the compound insoluble in water.

(*c*) Besides some organo-antimonial constituents, Urea Stibamine contains some antimony in the trivalent state (possibly present as antimonious acid) and some in pentavalent stage (possibly present as antimonic acid). The toxicity of the drug does not solely depend on its total antimony content but appears to be influenced also by the presence of antimonious and antimonic acids.

BOOK REVIEWS

Planning for Plenty.—By Sikander Chaudhury. Longman's New Era Series No. 1, Longmans, Green & Co., Ltd. Pp. 75. Price Rs. 1/8/-.

There have been so many tracts on planning of late that it has become increasingly difficult to see the wood for the trees. That there should be such a plethora of planning is natural. The planned economy of the Soviet Union which has made her one of the strongest powers of the world in the space of barely 20 years has put hope in the hearts of the relatively undeveloped nations of the earth. The success of Soviet planned economy has offered a sharp contrast to the chaos, which *laissez-faire* economy in the rest of the world has brought about. It is therefore been increasingly realised that if India is to have a forced and ordered march in her development she has to have a plan. Many individuals, committees and organisations have therefore got busy about it. We have the "Bombay Plan", the "People's Plan", the "Gandhian Plan" and sundry minor ones. The book under review has attempted to place these different plans in perspective and has sought to clarify the fundamental issue which has usually been obscured in a forest of details.

The author points out that arithmatic calculations regarding the targets for our production of food, clothing etc., as are given in the Bombay Plan are easy enough. The question which is fundamental to all planning is on what economic system is that production to be organised. The authors of the Bombay Plan have accepted the existing capitalist order as the basis for their plan. The writer of the book points out that this is "prescribing functional cures for what is an essentially organic disorder. The decennial swings of the trade cycle (under capitalism) are superimposed on an underlying curve of steady decline. Their violence may be controlled by careful planning of internal adjustments. But the basic decline would still persist. And it will defy understanding unless the economy is viewed as a whole and its over-all movement is recognised to be the central problem for enquiry." The author then proceeds to give a wealth of arguments on Marxist lines to show how the capitalist structure of production can never bring about the results which the Plan claims. It shows that the benefits that modern industrial technique can give to all men are frustrated by the operations of a capitalist economy and whatever devices have been made to reduce the rigours of the periodic crises have at best been weak palliatives without affecting the essential inability of the capitalist system to solve the problems posed to it by the onward march of science and technique. Further, since India is a late-comer into the company of industrial nations, her problems are considered still more difficult of solution in a capitalist frame-work. In this connection, it is interesting to recall the recent meeting of Mr Johnston of America with Stalin, in which the latter predicted unemployment in the U. S. A. sometime after the war. Mr Johnston did not agree. But already a Government spokesman in America has stated that they expect the number of unemployed to go up to 7 million in course of a year.

The author also criticises Part II of the Bombay Plan, in which a "judicious combination" of the principles of capitalism and socialism is advocated. He says that the type of control now being exercised by capitalist States is not tending towards socialism but is indeed helping the transition from free competition to monopoly and is ensuring profits to the owners of the means of production. Socialism connotes the nationalisation of the means of production

and, unless this is done, all talk of State control as tending towards Socialism is a dangerous snare. The Bombay Planners suggest that the variation in industrial income permitted in the Soviet Union is a deviation from Socialism. This, it is rightly pointed out, is a fallacy, because, the cardinal point of socialism is that the means of production shall not be used for private profit but shall be owned by and utilised for the community and this has been accomplished in the Soviet Union. To each according to his need is an end which can be attained only when production has reached very great heights. This, however cannot be achieved unless socialism is accepted as the basic structure of society, as under socialism alone can wealth be continuously increased.

The "People's Plan" is also criticised. Though it is more explicit on the public ownership of the means of production, it does not go sufficiently ahead and the difficulties involved in compensating the present owners of the means of production appear to be oversimplified. In order to start with the least handicap, minimum compensation would naturally be preferable and the writer says that the concrete question of the amount or nature of compensation can only be determined by the balance of the political forces prevailing at the time. In this connection it would be interesting to watch the methods by which the new Labour Government in Britain proceeds to nationalise the coal resources, railways, etc.

The author criticises the "Gandhian Plan" of Mr N. Agarwal and shows by a searching analysis that in essence it is a programme for poverty. If we ignore the machines which have greatly increased man's powers of production, we would be denying ourselves the plenty, which these machines have placed within the reach of humanity. The present misery has not been brought about by the machines but by the capitalist system under which they are operated. This is a truism, which, unfortunately, in spite of frequent repetition, still fails to be realised by large numbers of people. The "Gandhian Plan" concedes the necessity of an armament industry under present conditions and yet dislikes the growth of basic and ancillary industries on which an armament industry is based. This is one of the many curious inconsistencies of the Plan. The Plan does not urge abolition of private ownership of all means of production. It is indeed a fine synthesis between capitalism and cottage industry which at best is a meaningless dream and at worst a smoke-screen for the perpetuation of privilege, backwardness and poverty.

The tragic feature of our times is that even when the chaos and ruin brought about by capitalist economy during the last few decades stare us in the face and socialism stands out as the only high-way at the cross-roads of civilisation, attempts are made to avoid it and get into lanes and by-paths which can only lead to treacherous bogs. Whether it is the fascist brand of capitalism, or orthodox democratic capitalism or the new variety of capitalism under State control masquerading as partly socialistic, or the Gandhian economic order, it almost always wants to retain the main base of capitalism, which has been the cause of all our woe in the 20th century. It is not impossible that certain features of the Gandhian Plan with regard to Indian village communities may with advantage be incorporated into a socialist system, but it is high time it were realised that unless the modern scientific technique operating in a socialist economic structure is accepted as the basis for future development, our long night will never dawn.

This little book is a very ably written and closely argued pamphlet on the fundamental aspects of planning and ought to be read by all people who are interested in clear thinking on this subject.

Root Disease Fungi.—By S. D. Garrett, Waltham, Mass., the Chronica Botanica Co.; Calcutta, Macmillan & Co., Ltd. 1944. Pp. 177. $4·50.

This book bears a sub-title, "A Treatise on the Epidemiology of Soil-borne Disease in Crop Plants and a First Exposition of the Principles of Root Disease Control." The sub-title is more apt than the title for the book deals with the fungi as they cause diseases and with the diseases they cause, rather than with the fungi on their own account. Inasmuch as it does so, it is a welcome addition to the book-shelf of the plant pathologist, for it is notorious that emphasis has all too often, in research and in teaching, been laid upon the form of the fungus, with too little regard to its biology and particularly the pathology of the disease it causes.

The treatise starts with a consideration of micro biological equilibrium and with special reference to antagonism as it relates to the control of root diseases. The fungi causing root diseases are then classified into soil-inhabiting and soil-invading fungi and the author, an expert on the subject, has given a clear exposition of the difference between these two great groups.

The spread, or rather growth, of fungi in the soil, externally and within the host, is then considered. Those not fully acquainted with the research on root-infecting fungi will be surprised at the marked difference in behaviour of different fungi. Some may directly grow through the soil independently of infected host tissue, but the general rule is that they start from a well-supplied food base from which they

spread in various ways within the host tissue, or externally by individual hyphae, by aggregations of hyphae, by mucilaginous binding of hyphae, by rhizomorphs, etc. One feels at this stage a need for more detailed consideration of the nutrition of the fungi from the purely physiological point of view, for it seems evident to one who has followed closely the development of research along these lines that nutrition and antagonism are vitally linked. The question of dispersal of the parasitic fungi, by planting material, infected crop residues, wind, water and so on are discussed, in a later chapter (Ch. 10) which might well have had an earlier position in the book.

The influence of various factors, such as soil temperature, soil moisture content, texture, reaction, soil organic content and plant nutrients upon parasitic activity of the fungi is dealt with thoroughly. Chapter 8 deals with dormancy of the root-infecting fungi and the various devices of the fungi for overcoming unfavourable soil conditions. The cases quoted are few, reflecting how little is our knowledge, except in a few widely studied diseases such as *Synchytrium endobioticum, Plasmodiophora brassicae,* some smut fungi *Phymatotrichum omnivorum.* A vast amount of effort has gone into the study of *Fusarium* diseases of crop plants, one of the most important of all the root-infecting groups. Many of these form chlamydospores and some form sclerotia. How long can a chlamydospore or a sclerotium of *Fusarium* retain its vitality in the soil? Nobody knows. It is a serious gap in our knowledge.

The remainder of the book deals with the principles and practice of root disease control. It is worth while quoting from the author's introductory paragraph to this portion. "Any measures that are suggested for control of a soil-borne disease affecting a single crop have therefore to be considered in relation to their effect not only upon that particular crop, but also upon the other crops in the rotation and upon the maintenance of stock as well. Needless to say, the former will adopt those control measures which involve minimum expense and interference with his established routine; control of soil-borne diseases must therefore be sought rather through improvement of general farming policy than through expensive special operations." This is very true. The author has drawn his examples mostly from American and British farming, but would have come to similar conclusions from Eastern agriculture. He would then, however, have been faced with infinitely more difficult problems, for "interference with established routine" can, under Eastern conditions, only be tolerated if vast projects are undertaken. Consider, for instance, the case, not mentioned by the author, of wilt of gram, a staple crop of north-western India. Gram is the best pulse crop that can be grown in these dry areas, but wilt often destroys it. It has now been found that delay in sowing by a matter of 3 or 4 weeks, until the soil temperature has become unfavourable for disease development, greatly reduces the loss and increases the yield, provided there is sufficient moisture in the soil after the delay to promote germination and establish the crop. Unfortunately this cannot be relied on and the cultivator dare not risk the method unless he has irrigation facilities extended up till the end of September. This kind of facility is now being advocated enthusiastically in Upper India and may take a hold because wheat grown after September flooding gives far better yields. Thus the system may serve a dual purpose and may be adopted, but involves heavy expenditure on irrigation projects.

One is surprised that emphasis has not been laid on the importance of weeds as a source of infection for the root diseases. It is of notable importance in some countries in the case of take all of wheat and common root of the cereals generally.

Mixed cropping has necessarily received brief mention, for little work has been done in this connection. Large areas of the Eastern Hemisphere are devoted to mixed cropping, often by broadcast methods, and it is not the fault of the author that the influence of this practice on the development of root diseases has received so little attention by workers on the spot.

The portion dealing with the control of plantation crops is thorough and reflects the careful research that has gone into the problem, particularly in rubber plantations. In contrast, the section dealing with soil sterilization is rather brief and one would like a more thorough treatment. The sweeping statement that the consideration of chemicals other than formaldehyde for the purpose of controlling root-infecting fungi is a "waste of time" will not receive widespread agreement. Certain organic mercurials and other compounds are extensively used, we believe, in Europe for the control of club-root of cabbages in seedling beds and at the time of transplanting. Again, Bordeaux mixture of high concentration has been found to be the only practical and profitable means of controlling the devastating soil-borne wilt disease of pan (*Piper betle*) caused by *Phytophthora parasitica* in India, where the crop is intensively grown and is a valuable cash crop in many areas.

This book, as an exposition of principles, should appear on the bookshelf of every plant pathologist. It deserves a thorough reading and the bibliography will be found useful for reference purposes.

The book is well printed on good paper, references appear to have been carefully checked and it is well indexed. The price ($4·50) is reasonable.

G. W. P.

Thomas Jefferson and the Scientific Trends of His Time.—By Charles A. Browne. Chronica Botanica, Vol. 8, No. 3 (1944), Pp. 363-423, with 17 contemporary drawings, maps and fascimiles. Published by Waltham, Mass, the Chronica Botanica Co.; Calcutta, Macmillan & Co. Ltd. Price $1·25.

Thomas Jefferson (1744-1827), the third and one of the most versatile of the distinguished men, elected as President of the United States (1801-1809) was a man of great statesmanship and broad vision, such as rarely appear upon the stage of history. Jefferson's natural inclination was more towards science than politics and though the trend of events caused his career to fall in the latter field "he strove as resolutely to create a democracy of science as he did to establish a democracy of government."

The recent commemoration of the bicentenary of Jefferson's birth followed by this scholarly essay written by the doyen of the American Agricultural Chemists, elaborating Jefferson's position in the world of Science, his "notes on State of Virginia", his scientific services to new republic of the United States, his agricultural and educational work and some of the eminent contemporaries who knew Jefferson personally and exchanged with him letters throws much light on the scientific movements of his period. When historians are following the political ideas of Jefferson back to their origins, it is fitting that the sources of some of his scientific opinions should also be traced.

As an organizer of remarkable ability, Jefferson was a good judge of men and had marked success in selecting the best qualified persons to carry out his project,—whether the problem was outlining a rotation of crops, devising a system of weights and measures, preparing a curriculum of studies, planning a new university, or arranging, the complicated project of a scientific expedition.

Contemporary history reveals, that few persons in the United States equalled Jefferson's knowledge in botany and zoology and in recognition of his knowledge of natural history, the most fitting tribute is paid to Jefferson in creating a new genus named after him *viz., Jeffersonia* Barton.

A. K. G.

Battle for Health.—By Stephen Taylor, M.D., M.R.C.P. Published by Nicholson & Watson, London. Price 5*s*. net.

There is at the present moment an unmistakable need for educating the public about the social aspects of health and diseases. Time is ripe to dispel the common misconception that diseases are the concern of only medical practitioners, researchers, and hospitals and clinics. War against diseases has now increasingly become an important social responsibility to be shared by every individual in an all-out effort to attain victory. This war, as the author puts it, is fought in Parliament and on the Borough Council, in the factory and the mine, in fields where food is grown and shops where it is sold, in the school and in home. It is a total war against invisible enemies represented by micro-organisms which have killed, and are still killing, a far larger number of men and women than have actually died in all the wars waged between man and man. Unlike all other wars, this war has united mankind in its successful prosecution.

Dr Stephen Taylor describes the fascinating story of this war against diseases on such fronts as the typhoid, small-pox, rabies, tuberculosis, diptheria, rheumatic heart disease, venereal disease, and the diseases of the children, particularly as it is fought in Great Britain. 13 Isotype charts, numerous pictorial illustrations and statistical tables, and above all, the lucid and convincing style of the author will have its immediate effect on the reader. The *new democracy* is yet to score a victory over the axis combination of poverty, disease and malnutrition in the post-war period, for which the first important step is a relentless campaign, through education, against widespread ignorance about these problems. Dr Taylor's book, we trust, will be an important weapon in this campaign.

S. N. S.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

TEMPERATURE, pH, AND SPECIFIC GRAVITY OF THE WATER OF A BENGAL POND

GROWTH of fish depends much on temperature, p^H, and specific gravity of the water in which the fish live. As there is no record of such data of a Bengal pond throughout the different seasons of a year, we are giving here such a record in a tabular form from which it will be of use to those in the line who wish to compare their data with Bengal pond. The experiment was made in the pond of the University College of Science at 35, Ballygunge Circular Road, Calcutta and the following data were collected.

Month	Temperature of the water of the pond		p^H of the water of the pond		Specific gravity of the water of the pond	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January	75°F	78°F	7·5	7·6	1·002	1·003
February	76°F	78°F	7·6	7·6	1·003	1·006
March	82°F	95°F	7·6	7·7	1·003	1·007
April	91°F	108°F	7·6	7·7	1·004	1·007
May	90°F	100°F	7·4	7·6	1·004	1·007
June	89°F	96°F	7·4	7·5	1·005	1·009
July	88°F	94°F	7·3	7·5	1·006	1·009
August	87°F	95°F	7·3	7·5	1·007	1·01
September	94°F	98°F	7·4	7·6	1·006	1·01
October	84°F	88°F	7·5	7·7	1·003	1·006
November	82°F	85°F	7·6	7·7	1·002	1·005
December	77°F	81°F	7·6	7·6	1·003	1·006

Zoology Department,
Calcutta University,
Calcutta, 4-6-1945. H. K. MOOKERJEE

THE ELUTRIATING EFFECT OF SALTS OF CARBOXYLIC ACIDS ON THE PHOSPHATASE-ALUMINA GEL

ALTHOUGH several adsorbents have been suggested for the purification of enzymes, very few elutrients have been used for liberating enzymes from their adsorbents. Elution is generally effected by an alteration of p^H or by the displacement of the enzyme from the adsorbent, as in the case of phosphate as elutrient for alumina adsorbates.

In the course of our investigations on the purification of leaf phosphatases, we noticed an interesting phenomenon which indicated the possibility of establishing certain relationship between the nature of the salts of carboxylic acid and their effectiveness in eluting the enzyme from the adsorbate. Leaf phosphatases are found to be readily adsorbed on Alumina C_γ at p^H 3.6. But the elution of the enzyme is not possible by using the common elutrients which are known to liberate enzymes from the alumina gel. Schmidt and Thannhauser[1] have recently shown that phosphatases once adsorbed on Alumina C_γ cannot be recovered in soluble form. They have, therefore used the adsorbent for removing contaminating substances leaving the enzyme in solution, the adsorbent being added in very small concentrations. We have, however, succeeded in liberating the enzyme from Alumina C_γ by using salts of carboxylic acids as elutrients. The results of these experiments are presented in the following table. The concentration of the substances used was 10 per cent and the p^H was nearly neutral in all cases.

ELUTION OF LEAF PHOSPHATASE (FRENCH BEANS) FROM ALUMINA C_γ

Elutrient	Activity of the Alumina C_γ-phosphatase adsorbate	Activity of the phosphatase eluted	Elution per cent.
Ammonium acetate	28·1	8·6	30·6
Sodium acetate	28·1	13·6	48·4
Calcium acetate	28·1	21·0	74·5
Sodium oxalate	28·1	21·0	74·5
Sodium citrate	28·1	23·5	84·0
Sodium tartrate	28·1	27·2	97·0

From the results reported in the table the following order of their increasing effectiveness in the extraction of the phosphatase from the adsorbate is obtained: acetate<oxalate<citrate <tartrate.

The behaviour of these salts of carboxylic acids can be explained by the theory advanced (Gustavson[2]) to explain the removal of chromium from chrome tanned leather by treatment with sodium potassium tartrate solution. According to this theory some groups of the collagen molecule displace the coordinately bound groups in the complex chromium micelle resulting in the formation of a chromium compound in which some groups of the protein molecule are inside the nucleus, while others are outside. Groups of higher penetrating capacity may displace these coordinately bound groups. In similar manner the enzyme is adsorbed by the alumina gel because some of the groups of the molecule penetrate into the complex aluminum ionic micelle and displace other coordinately bound groups from it. The elution of the phosphatase from the adsorbate appears to depend upon the greater penetrating capacity of the anions of the salts of the carboxylic acids into the nucleus than the enzyme resulting in displacing the enzyme from the alumina gel. The penetrating capacity of the salts depend not only on the nature of the anions of the salts used but also on the cations, as the calcium salts are found to be more effective than the sodium salts in eluting the enzyme from the alumina gel.

Further systematic investigation is in progress to elaborate the above hypothesis and to establish the relationship existing between the nature of various salts of carboxylic acids and their effectiveness in liberating the enzyme from alumina gel.

R. Das
K. V. Giri

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 27-6-1945.

[1] Schmidt and Thannhauser, *J. Biol. Chem.*, *149*, 369, 1943.
[2] Gustavson, K. H., *J. Amer. Leather Chem. Asson.*, *18*, 568, 1923; *19*, 444, 1926; *21*, 22, 1926; *26*, 635, 1931; *J. Amer. Chem. Soc.*, *48*, 2963, 1926.

A STABLE ORGANO-ANTIMONIAL DRUG FOR THE TREATMENT OF KALA-AZAR

The ideal drug for the treatment of Kala-azar should be capable of oral or intramuscular administration, should be therapeutically very potent and absolutely devoid of any untoward reaction. Chemically, it should have a fixed constitution and should be stable. No drug so far known meets all these requirements but the development of active synthetic compounds clearly points to the possibility of still better ones being discovered.

In the search for an ideal drug for the treatment of Kala-azar, a stable salt has been prepared by the interaction of *p*-aminophenylstibinic acid (purified through the corresponding *chloride*, prepared by treatment with cold hydrochloric acid) with pure tri-*iso*-propylamine, distilling at 195°/15 mm. It is a stable, greyish white solid, soluble in water to give a red, stable solution, and practically insoluble in alcohol or ether. It contains about 36% antimony.

The highest tolerated dose of the drug, when injected into mice subcutaneously, is being found to be 400 mg/kg. It passes the intravenous toxicity test on mice in dosage of 300 mg/kg with a mortality of 2/10. In rats the usual skin irritation test is also passed without any reaction. Thus, the drug is devoid of any undue toxicity and is not irritant.

In view of the low toxicity of this drug and the promising result of the tests on animals, its clinical trial by intramuscular route is under investigation. In this connection it should be mentioned that the purity of tri-*iso*-propilamine is a very important factor and any trace of impurity, if present, is liable to make the above salt more toxic and irritant.

Our thanks are due to Dr U.P.Basu for his interest in this investigation.

T. N. Ghosh
A. N. Bose
S. N. Mitra

Bengal Immunity Research Laboratory,
Calcutta, 16-7-1945.

ON N¹ AND N⁴ SUBSTITUTED SULPHANILAMIDES PART I

In an attempt to improve and expand the chemotherapeutic activity of sulphanilamide a large number of its derivatives have been synthesised of which the sulphanilamido heterocycles have been found to be promising. This consideration suggested the preparation of a number of new heterocyclic derivatives of both N¹ and N⁴ substituted sulphanilamides in order to ascertain in what respect their activity is generally affected by the introduction of such rings. In the selection of heterocyclic ring to be attached to sulphanilamide, the choice fell upon pyrazolone, oxypyrimidine and thiazole.

The following compounds have been prepared:—

1. 1-(p-sulphonamidophenyl - 3-methyl-5-pyrazolone. m.p. 246°.
2. 1-(p-sulphonamidophenyl) - 3-methyl - 4-(p-sulphonamido - azobenzene) - 5-pyrazolone. m.p. 298°.

3. 1-(phenyl-p-carboxylic acid) - (3-methyl-5-pyrazolone. m.p. 278°.
4. 1-(phenyl-p-carboxylic acid)-3-methyl-4-(p-sulphonamido - azobenzene) - 5-pyrazolone. m.p. 291°.
5. 1-(phenyl-p-sulphonic acid)-3-methyl-5-pyrazolone. m.p. 306°.
6. 1-(phenyl-p-sulphonic acid)-3-methyl-4-(p-sulphonamido - azobenzene) - 5-pyrazolone. m.p. above 320°.
7. N^1 - antipyrine-N^1 - acetyl-sulphanilamide. m.p. 265°.
8. N^1-antipyrine-sulphanilamide. m.p. 249°.
9. 4-(p-sulphonamido-azobenzene) - 3-amino-5-pyrazolone. m.p. 274°.
10. 2-(p-acetyl-sulphanilyl) - 3-methyl - 5-pyrazolone. m.p. 195°.
11. 2-sulphanilyl-3-methyl-5-pyrazolone. m.p. 169°.
12. 1-(p-acetyl-sulphanilyl) - 3-methyl-5-pyrazolone. m.p. 167°.
13. 2 :4 diamino-thiazole hydrochloride. no m.p.
14. 2 :4 diamino-5-(sulphonamido-azobenzene-thiazole. m.p. 185°.
15. 2 :4 diamino-6-o pyrimidine - 5-(p-sulphonamino-azobenzene). m.p. above 300°.
16. Sulphanilyl guanidine. m.p. 189°.

Roblin[1] has reported compounds Nos. 8 and 16 but they have been prepared by us by methods quite different from those of Roblin.

In an attempt to synthesise sulphapyridine by heating acetyl-aminobenzenesulphonazide with pyridine[2] we obtained a solid (m.p. 284°) which separated out of the pyridine solution during heating. Constitution of this substance has been established by one of us.[3] From the pyridine solution three more different compounds[4] have been isolated. The character of these compounds are now engaging our attention and the interesting results obtained will be communicated by one of us elsewhere in due course.

Further details on the preparation of these compounds will be published elsewhere. The pharmacological studies of these compounds are in progress.

S. C. De
P. K. Datta

Chemical Laboratory,
Department of Organic Chemistry,
Dacca University,
Dacca, 25-7-1945.

[1] Roblin, Williams and others, *Jour. Amer. Chem. Soc.*, 62, 2003.
[2] Curtius, *J. Pr. Chem.*, *126*, 112, 1926; *125*, 326, 1930.
[3] Bose, S. N. and Datta, P. K., Science and Culture, 9, 48, 1943.
[4] These compounds have the melting point 296°, 185° and 101°, respectively.

ON THE GLUCOSIDES OF SULPHANILAMIDE AND ITS DERIVATIVES. PART II

It has been remarked by Brooks that met-hæmoglobin in blood is produced by oxidation of hæmoglobin by sulphanilamide and the remedy suggested for this is the intravenous injection of glucose solution which immediately reduces met-hæmoglobin to hæmoglobin thereby permitting blood to carry oxygen again. These facts have led us to prepare glucosides of sulphanilamide and its derivatives which will supply glucose in the system when required for the reduction of met-hæmoglobin and also for nutritional purposes. Moreover, introduction of the glucose residue greatly increases the solubility of the drugs. To increase in the solubility of such drugs it is the common practice to use sodium salts which are undesirable on account of the high *p*H value of their aqueous solutions.

The following compounds are reported :—

1. N^1-acetyl sulphanilamide. m.p. 180°.
2. N^1-acetyl-N^4-glucose sulphanilamide. m.p. 185°.
3. N^1-(2-pyridyl)-N^4-glucose sulphanilamide.

To prepare compound No. 1 sulphanilamide was acetylated to the corresponding 1 :4 diacetyl derivative which was then hydrolysed under carefully controlled conditions.

Compound No. 2 was prepared from compound No. 1 and glucose in presence of a catalyst.

Compound No. 3 was prepared by the same method as compound 2 from sulpha-pyridine and glucose. The substance is extremely hygroscopic becoming sticky the moment it comes in contact with the atmosphere and its melting point could not be correctly taken. On warming or keeping its aqueous solution for three or four days at room temperature the substance decomposes, a solid separating out which is 2-sulphanilamido pyridine.

Preparation of N^1 glucose sulphanilamide was also attempted, but this resulted in the formation of a tarry mass from which no definite compound has yet been isolated.

Preparations of other such glucosides are in progress. Details of their preparations will be published elsewhere.

P. K. Datta
S. C. De

Chemical Laboratory,
Department of Organic Chemistry,
Dacca University,
Dacca, 25-7-1945.

ON N' AND N' SUBSTITUTED SULPHANILAMIDES PART III

ALTHOUGH in practice there are at present a number of derivatives of sulphanilamide fairly effective against hæmolytic streptococci, pneumococci, etc. yet nowadays highly effective remedies for tuberculosis, plague and a number of other diseases are badly lacking. It is for this reason that widely different derivatives of sulphanilamide are being synthesised and bactereologically studied. In the present communication are reported the preparation of a number of new heterocyclic derivatives of sulphanilamide as well as a number of its azo derivatives and sulphanilyl heterocycles. The heterocyclic ring chosen is barbituric acid and its homologues, the chief reason for which is to combine the hypnotic effect of barbituric acid whose derivatives are the most commonly used of the hypnotics in modern times and the bactericidal activity of sulphanilamide. The following compounds of the general formulae I-IV

R-N-CO
CO CH.-N-N-C_6H_4-SO_2-NH_2
R-N - CO
p-sulphonamido-phenyl-5-azo-barbituric acids.
(I)

R-N - CO
CO CH-SO_2-C_6H_4-NH_2. CO.CH_3
R-N - CO
5-(p-acetyl-sulphanilyl)-barbituric acid.
(II)

R-N - CO
CO CH-N-N-C_6H_4-SO_3H
R-N - CO
phenyl-5-azo-barbituric acid p-sulphonic acid.
(III)

R-N - CO
CO CH-NH-SO_2-C_6H_4-NH.$COCH_3$
R-N - CO
5-(p-acetyl sulphanilamido)-barbituric acid.
(IV)

in which R - H, CH_3, C_2H_5, C_6H_5, C_6H_5. CH_2., have been prepared.

Further details on the preparation of compounds of the above types will be published elsewhere in due course.

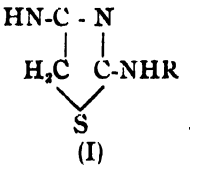
Studies on the pharmacological effect of these compounds are in progress.

S. C. DE
S. P. DHAR

Chemical Laboratory,
Department of Organic Chemistry,
University of Dacca,
Dacca, 25-7-1945.

ON N' AND N' SUBSTITUTED SULPHANILAMIDES PART IV

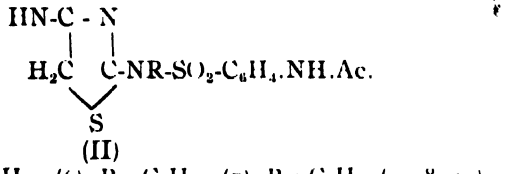
ALTHOUGH only one sulphanilamide derivative of reduced thiazole has been reported and shown to be therapeutically active, no systematic investigation seems to have been made on the preparation of sulphanilamides having in position N', a reduced thiazole ring as substituent. With this object the following hitherto unknown reduced thiazoles of the general formula (I) have been made.



(I)

(1) R=H, (2) R=C_2H_5, (3) R=C_6H_5, (4) R=C_7H_7 (o- & p-)

With the exception of compound No. 1, the remainder were successfully combined with p-acetyl sulphanilyl chloride to yield compounds of the general formula (II)

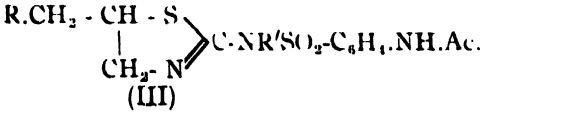


(II)

(5) R=C_2H_5, (6) R=C_6H_5, (7) R=C_7H_7 (o- & p-)

In contact with alkali compound No. 1 rapidly formed a red coloured solution from which a chocolate coloured solid was obtained which refused to combine with acetyl sulphanilyl chloride. The character of this red coloured substance is under investigation.

In addition, the following sulphanilamide derivatives of the already known reduced thiazoles of the general formula (III) have also been made.



(III)

(8) R=H, and R'=H, (9) R=H, and R' C_6H_5, (10) R=H, and R'=C_7H_8, (11) R=Br, and R'=H, (12) R=I, and R'=H.

Details of the preparation of the above compounds will be published elsewhere. These compounds are awaiting pharmacological examination.

S. C. DE
M. HOSSAIN

Chemical Laboratory,
Department of Organic Chemistry,
Dacca University,
Dacca, 25-7-1945.

SCIENCE AND CULTURE

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PROGRAMME OF POST-WAR SCIENTIFIC RESEARCH IN U. S. A.

IN one of our previous articles (Scientific Education and Research in Relation to National Welfare, SCIENCE AND CULTURE, March, 1945) an account was given of the war-time research undertaken in the U. S. A. under the newly created Office for Scientific Research and Development (O.S.R.D.) with Dr Vannevar Bush as Director. We also gave an account of the suggestions which were made by Dr Dunn for post-war support of fundamental research by the Federal Government. Recently a report to the President of the U.S.A. has been submitted by Dr Bush and now published under the title 'Science—the Endless Frontier', which was prepared in reply to President Roosevelt's letter of November 17, 1944, asking for recommendations on four specific points, which are:

(*i*) What could be done, consistent with military security, and with the prior approval of the military authorities to make known to the world as soon as possible the contributions which have been made during the war effort to scientific knowledge;

(*ii*) With particular reference to the war against disease, what could be done to organise a future programme of work in medicine and related sciences;

(*iii*) What could the Government do to aid research activities by public and private organization; and

(*iv*) Could an effective programme be proposed for discovering and developing scientific talent in American youth, so as to ensure the continuance of scientific research on a level comparable to that attained during the War.

Summaries of these recommendations are published in *Science* (27th July, 1945) and *Nature* (4th August, 1945), and our present account is based upon them.

To appreciate the significance of the recommendations proposed by Dr Bush, it is necessary to understand how little was undertaken by the Federal Government, till the beginning of the present war, to support higher education and research in the U. S. A. The universities and colleges were either founded by different States, such as Wisconsin, Michigan, Minnesota, and California, or privately endowed like Harvard, Yale, Chicago, Columbia. Both types of institutions have received in recent years large grants from several large philanthropic foundations such as the Rockefeller and the Carnegie. The Federal Government only maintain a number of land grant colleges and institutes for education and research in agriculture and for mechanical training. In addition a number of scientific departments have been maintained by the Federal Government who also support applied researches in the War and Navy Departments.

In the U. S. A., research, both fundamental and applied, has been undertaken by industry and Government, by colleges and universities, and by research institutes. The first two named bodies have concerned themselves chiefly with applied research, while the other two bodies have concerned themselves mostly with fundamental researches. But there were no organisations similar to D. S. I. R., Medical Research Councils which were established in the United Kingdom after the first World War to co-ordinate and support research in various basic and applied sciences.

It was only during the recently terminated war that the O.S.R.D. was set up to subsidise applied research by means of contracts with academic and Government institutions and industrial organisations. According to the figures collected by Dr Bowman,

expenditures for scientific research by industry and Government increased from $140 million in 1930 to $309 million in 1940. Those for colleges and universities from $20 million to $31 million while those for research institutes declined from $5·2 to $4·5 million during the same period. Since basic research is scientific capital, without which no applied research is possible, it is suggested by Dr Bush that to enable colleges, universities and research institutes to meet the rapidly increasing demands of industry and Government for new scientific knowledge, their basic research should be strengthened by use of public funds.

The main recommendation for implementing the general finding and conclusion of the report that the Federal Government should accept new responsibilities for promoting scientific research and the development of scientific talent in youth, is the creation of a National Research Foundation. The Foundation proposed would be responsible to the President and to Congress, while assuring complete independence and freedom for the nature, scope and methodology of research in the institutions receiving public funds and retaining discretion in the allocation of funds among such institutions. Such responsibility, Dr Bush urges, is the only means of maintaining the proper relation between science and other aspects of a democratic system, and he considers that a Government programme of support for scientific research and education must be based on four further principles: stability of funds over a period of years to enable long-range programmes to be undertaken ; the agency administering such funds should consist of citizens selected only on the basis of their interest in, and capacity to promote, the work of the agency ; the agency should work through contracts or grants to organisations outside the Federal Government and should not operate laboratories of its own ; and support of fundamental research in colleges, universities and research institutes must leave the internal control of policy, personnel, and the method and scope of the research to the institutions themselves.

Accordingly, the Foundation proposed would consist of nine members appointed for, say, four years, and selected by the President in virtue of their interest in and understanding of scientific research and education. They would appoint a chief executive officer as director, and establish initially five divisions, covering medical research, natural sciences, national defence, scientific personnel and education, and publications and scientific collaboration. The function of the Division of National Defence would be to support long-range scientific research on military matters, leaving to the Services research on the improvement of existing weapons. The Division of Scientific Personnel and Education would be responsible for the support and supervision of the grant of scholarships and fellowships in science, while that for Publications and Scientific Collaboration would be responsible for encouraging the publication of scientific knowledge and promoting international exchange of scientific information. In this field the powers of the Foundation would include the provision of financial aid for international meetings, associations of scientific societies, and scientific research programmes organised on an international basis. Emphasizing that the success of the Foundation in promoting scientific research will largely depend on the co-operation of organisations outside the Government, Dr Bush suggests that while in its grants to, or contracts with such organisations the public interests must be adequately protected, the organisation should be left with adequate freedom and incentive to conduct research. Normally, the public interest would be adequately protected if the Government received a royalty-free licence for government purposes under any patents resulting from work financed by the Foundation. There should be no obligation on the research institution to patent discoveries made as a result of support from the Foundation, and no absolute requirement to assign all rights in such discoveries to the Government. Legislation should leave to the members of the Foundation discretion as to its patent policy, so that patent arrangements could be adjusted as circumstances and the public interest require. Rough estimates given in the report provide for an expenditure of $33,500,000 in the first year, rising to $122,500,000 in the fifth year. Of this total, five million rising to twenty are for Medical Research, ten each for the Divisions of Natural Science and National Defence, rising to fifty and twenty million respectively, and seven million rising to twenty-nine million for the Division of Publications and Scientific Collaboration.

These recommendations are based upon detailed reports from four committees on (*i*) Science and Public Welfare, (*ii*) Medical Advisory Committee, (*iii*) Publication of Scientific Information, (*iv*) Committee on the Discoveries and Development of Scientific Talent.

(*a*) *War Against Disease.*—In support of his recommendation, Dr Bush points out the great progress which has already been achieved in the war against disease, resulting in a reduction of death rate for all diseases in the army from 14·1 per thousand in the last war to 0·6 per thousand in the present war. In the last 40 years life expectancy has increased from 40 to 65 years. But the goal is still far off ; much illness remains for which adequate means of prevention and cure are not known.

The responsibility for basic research in medicine and the underlying sciences falls primarily on the universities and the medical schools. The traditional sources of support for medical research are diminish-

ing and the cost of medical research is rising. To maintain the present progress in medicine the Government should extend financial support to basic research in the medical schools and in universities.

(*b*) *National Security.*—For national security there must be more and more adequate military research in peace time. It is essential that civilian scientists continue in peace time some portion of those contributions to national security, which they made so effectively during the war. This can be best done by a civilian controlled organisation with close liaison with the Army and Navy, but with funds direct from Congress, and with clear power to initiate research which will supplement and strengthen that carried on directly under the control of the Army and Navy.

(*c*) *Public Welfare.*—For public welfare it is necessary to secure after the war full employment. To create more jobs it is necessary to make new and better and cheaper goods. Such new products and processes are not born full grown. They are founded on new principles and new conceptions which in turn result from basic scientific research. More and better scientific research is essential to the achievement of the goal of full employment. To realise this aim it is necessary (*i*) to have plenty of men and women trained in science, for upon them depends both the creation of new knowledge and its application to practical purposes ; (*ii*) to strengthen the centres of basic research, which are principally the colleges, universities and research institutes. These institutions provide the environment which is most conducive to the creation of new scientific knowledge and are least under pressure for immediate, tangible results. With some notable exceptions, most research in industry and in Government involves application of existing scientific knowledge to practical problems. It is only the colleges, universities and a few research institutes that devote most of their research efforts to expanding the frontiers of knowledge. If these institutions are to meet the rapidly increasing demands of industry and Government their basic research should be strengthened by use of public funds.

For Science to serve as a powerful factor in national welfare, applied research both in Government and in industry must be vigorous. To improve the quality of scientific research within the Government, steps should be taken to modify the procedures for recruiting, classifying and compensating scientific personnel in order to reduce the present handicap of governmental scientific bureaus in competing with industry and the universities for top-grade scientific talent. To provide co-ordination of the common scientific activities of these governmental agencies as to policies and budgets, a permanent Science Advisory Board should be created to advise the executive and legislative branches of Government on these matters.

The most important ways in which the Government can promote industrial research are to increase the flow of new scientific knowledge through support of basic research, and to aid in the development of scientific talent. In addition, the Government should provide suitable incentives to industry to conduct research, (*i*) by clarification of present uncertainties in the Internal Revenue Code in regard to the deductibility of research and development expenditures as current charges against net income, and (*ii*) by strengthening the patent system so as to eliminate uncertainties which now bear heavily on small industries so as to prevent abuses which reflect discredit upon a basically sound system. In addition, ways should be found to cause the benefits of basic research to reach industries which do not now utilise new scientific knowledge.

(*d*) *Development of Scientific Talent.*—The responsibility for the creation of new scientific knowledge and for the most of its application rests on that small body of men and women who understand the fundamental laws of nature and are skilled in techniques of scientific research. The real ceiling on the productivity and the development of new products and new industries is the number of trained scientists available. There are talented individuals in every part of the population all of whom cannot afford the expense of a full course of training in sciences and in methods of research, and, therefore, it is necessary that the Government should provide a reasonable number of undergraduate scholarships and graduate fellowships in order to develop scientific talents in American youths. The plan should be designed to attract into science only that proportion of youthful talent appropriate to the needs of science in relation to the other needs of the nation for high abilities. It is suggested that about 24,000 undergraduate scholarships and 900 post-graduate fellowships should be provided for the purpose.

(*e*) *Publications and Scientific Collaboration.*—With regard to the vast amount of accumulated information relating to the application of science to particular problems of the war, some of which must remain secret, the rest should be made public as soon as there is ground for belief that the enemy will not be able to utilise them for war against the U. S. A. Meanwhile the Government should take an active part in promoting the international flow of useful scientific information, and in addition to sponsoring of international scientific congresses, the establishment of international fellowships is advocated as well as the appointment of scientific attaches serving in selected U. S. embassies.

In many ways the report contains detailed and exhaustive recommendations. But there are also a number of noticeable omissions. There is no mention of the necessity of federal support of investigations in social sciences, social biology and of biologi-

cal factors in human relation, in psychology, all of which are necessary for the establishment of better social order and better human relations. There is no trace in it of Jefferson's ideal of the "brotherly spirit of science which unite into one family all its votaries of whatever grade, and however widely dispersed throughout the different quarters of the globe." There is no reference to the dictum laid down by Franklin Roosevelt that "we are faced with the pre-eminent fact that if civilisation is to survive, we must cultivate the science of human relationships—the ability of all peoples of all kinds to live together, to work together in the same world at peace". The proposals contained in Dr Bush's report are designed in a spirit of severe functionalism, to provide the maximum of material happiness to the people of the U. S. A., which accrues from an unlimited supply of consumer goods and from an increasingly successful warfare against illness and disease. Fundamental research and applied research are valued only for their utility in the realisation of the above aims. Further to safeguard the standards of material well being from interference by foreign powers, civilian research in devising new instrumentalities of war, like the production of atom bombs, is to be maintained and intensified. In line with this are proposals under consideration in the U. S. A. for the introduction of universal military service and of courses of military sciences in technical institutions. Even international conferences in science are to be encouraged for the supply of useful scientific information which can be gathered from them.

President Roosevelt in his last message to the American people said, "The only limit to our realisation of tomorrow will be our doubts of today. Let us move forward with strong and active faith." Surveying the world happenings of today, the repercussion of the dropping of atomic bombs on Japan, the development of power politics amongst the great powers, can we mobilise the 'strong and active faith' in a bright future? If President Roosevelt had been living now, possibly his robust idealism and magnetic personality would have guided his great country and also the other great powers through the turbulent years of post-war reconstruction to a more peaceful and happier world.

ACADEMIA SINICA*

JOSEPH NEEDHAM

Introduction

AS the highest research organization under the Chinese National Government, the Academia Sinica, despite the limitations on its finances, personnel and equipment, has carried on an extensive programme throughout Free China. It now maintains thirteen institutes: physics, chemistry, engineering, geology, astronomy, meteorology, zoology, botany, psychology, history and philology, social sciences, physical anthropology, and medicine. Until July, 1937, the first three institutes were located in Shanghai, while the central office and seven other institutes were all in Nanking. At present, the central office is temporarily located in Chungking; the institutes of zoology and botany, meteorology, physics, geology and psychology at Beipei; the institutes of history, philology, sociology and physical anthropology at Lichuang; the institutes of chemistry, astronomy and engineering in Kunming and that of medicine in Koloshan.

Academia Sinica was founded in 1928 in Nanking with the late Dr Tsai Quan-Pei as its President. He was a vigorous advocate of academic freedom and a source of inspiration not only to members of the Academy but to Chinese intellectuals in general. After his death in March, 1940, the Government appointed Dr Chu Chia-Hua acting-President. Before he entered political life, Dr Chu had been professor of Geology at Peiching University. During the period 1939-41, Mr Zen Hung-Chang and Dr Fu Se-Nien successively served as secretary-general. The latter resigned in the autumn of 1941 and Dr Yeh Chi-Sun, professor of physics in Chinghua University, was appointed to the post. He was succeeded by Dr Li Shu-Hua (concurrently acting-President of the National Peiping Academy) in 1944, who is assisted by a secretariat of seventeen members. There is also a Foreign Secretary, till recently the cytologist Dr Hsu Hsiang. The total number of scientists in the Academy is of the order of 255.

Although membership of Academia Sinica is a scientific honour, the structure of the Academy resembles that of the Moscow Academy of Sciences rather than the Royal Society of London or the National Academy of Washington, in that the academy finances and operates its own research institutes.

The National Research Council was organized as

* Based on an article originally written by Dr Yeh Chi-Sun.

a part of Academia Sinica in 1935. Its function is to promote and to co-ordinate scientific research in the whole country, the word "scientific" being used in the wider sense, including the social and historical sciences. Members of the council consist of the President of Academia Sinica, the Directors of its Research Institutes, and thirty members elected among professors of national universities. The term of office of the elected members is 5 years. The council ordinarily meets once a year. The present Minister of Economics and Natural Resources, Dr Wong Wen-Hao, acts as Secretary-General with two aides.

In 1941, the council decided to publish two journals, *Science Record* and *Bulletin of Academic Research*. The former contains short comunications on original scientific research by Chinese scientists, the language used being English, French, or German. The latter is published in Chinese, and contains general reviews of the significant advances in various fields of study and abstracts of scientific papers by Chinese scientists and of those by foreign scientists on subjects related to China. On account of the difficulties of printing in the interior, the first number of *Bulletin of Academic Research* did not appear until December, 1942, and the first number of *Science Record* appeared in February, 1943. It contained many interesting papers, such as those on the plant growth hormone activity of sulphanilamide drugs, by Dr Tang Pei-Sung and his colleagues ; on the symbiosis between the termite *Aegerita duthiei* and the fungus *Collybia albuminosa* by Dr Chou Chia-Tze ; on crystal physics by Dr Yu Rjui-Huang ; on soil micro-organisms by Dr Gao Shang-Yin ; and on many aspects of geology and higher mathematics.

Institute of Astronomy

The Institute was founded in 1928 but the construction and equipment of its observatory on the Purple Mountain near Nanking was not completed until 1934. After only three years of using this equipment, the Institute had to move to Kunming and lost most of the heavier instruments. Since Kunming is noted for the clearness of its sky during the dry season, it was decided to build there a small observatory at Yangfangwa which was completed in 1938. The spectrohelioscope was again set up and is used for daily observations of sunsports. A Ross camera with 4-inch objective for the study of variable stars was also set up again.

The total solar eclipse of September 21, 1941, was a rare opportunity for the Chinese astronomers. The path of the shadow swept across the country from the Northwest towards the Southeast, covering a distance of over 4,000 kilometers. A number of years ahead of the event, a plan of collaboration had been organized by the institute, the National Central University, the University of Nanking and the Institute of Physics of Academia Sinica. The exigencies of the war demanded the curtailment of the original programme, and only two observation parties were sent out on the Fukien province, and another to Kansu province. Clear sky greeted the latter party though not the former and the members successfully photographed the corona, determined the times of contacts, and found that the light intensity of the corona was 0.30 that of the full moon. The eclipse expedition made a great impression upon the populace who had formerly never realized that modern science could predict a celestial event with such precision.

On February 2, 1941, a member of the institute found the comet 1941 C. Paraskevopoulos. He made a number of observations and computed the elements of its orbit.

Dr Tai Wen-Sai joined the institute in the autumn of 1941 and is now engaged in theoretical astrophysics, observational work being impossible under present circumstances. In 1942, he completed two papers, one on the convective equilibrium and colour temperature of stars, and the other on the analysis of some peculiar stellar spectra.

The observatory at Yangfangwa possesses a good library. The present director (1945) is Dr Chang Yu-Chih and there is one Senior Research Fellow, two Observers, one Junior Research Fellow, and three Assistants. One of the staff has done valuable wartime work in the popularization of astronomical knowledge.

Institute of Meteorology

Since its foundation the institute has been in charge of both service and research work. Before the Japanese invasion, with the Central Meteorological Observatory in Nanking, the institute had in its charge a number of weather and rainfall stations scattered throughout the country. After successive removals which took place after the fall of Nanking in 1937, the institute settled down again at Beipei near Chungking, carrying with it a part of the observational equipment of the Central Meteorological Observatory. The number of instruments now in use in the temporary quarters is, of course, much less than that formerly in use in Nanking. In fact, the resumption of self-registered weather records did not begin until January, 1942.

Members of the institute have been faced with many difficulties. For instance, they realized the importance of observations of upper air wind drift ; but from October, 1941 to May, 1942 only 66 balloons could be sent up, because the necessary equipment were not available.

In the autumn of 1941, the National Government inaugurated the Central Weather Bureau, and Dr Lu Chung, previously acting-director of the institute, went to head it. The 17 weather stations and 100 rainfall stations, formerly under the direction of the institute, were transferred to the bureau. Henceforth the members of the institute devoted themselves to research in the science of meteorology itself, to statistical analyses of weather data, and to the climatology of China.

The papers of the institute, besides appearing in monographs and memoirs, mainly appear in the *Meteorological Magazine*, published by the Meteorological Society of China. To the latest issue of this magazine, Dr Cheng Tze-Cheng of the institute contributed an article on the climatic regions of Szechwan, and Mr C. C. Yang an article on the upper air currents over southern Szechwan.

The director of the institute (1945) is Dr Chu Ko-Chen (concurrently President of Chekiang University), the acting-director is Dr Chao Chiu-Chang, and there are three Research Fellows with ten Assistants and Technicians. An interesting recent development has been the training of Buddhist, Lamaist and Taoist priests, who often live in temples on high mountains, to cooperate in taking regular meteorological observations.

Institute of Geology

At the beginning of the war, the institute moved to Liangfeng, near Kweilin in Kuangsi province, where it had good temporary accommodation in and near the Kuangsi Science Institute. Members of the institute, to meet wartime needs, paid much attention to the mineral resources of south-western China. In co-operation with other Chinese geological institutes, the mountainous area in western Hupeh, western Hunan, the eastern border of the Kweichow plateau, the "Kuangsi Plateau" and the Nanling Ranges have been explored. These are areas in which metalliferous deposits abound. Hitherto they were comparatively little known geologically owing to their highly mountainous character. With the rapid development of motor roads in these areas, field-work has been greatly facilitated. Consequently, important results have been obtained within the past few years regarding ore deposits as well as geological development.

Ore bodies either in the form of lenticular layers or persistent veins, or else of irregular masses have been located with respect to principal structural trends and to the alignment of igneous intrusions. They are mainly formed in the older rocks, and particularly in those of Sinian age. Tin, tungsten, gold, antimony, lead, zinc, mercury, together with iron and coal are among the principal elements being studied.

Stratigraphical, tectonic and geomorphological observations made in the mountainous areas are contributing much toward the elucidation of important geological events. Of wider scientific interest is the investigation of the extensive distribution of an ancient glacial deposit, or tillite, along the eastern border of the Kweichow plateau. This deposit can be compared, in point of time, with a similar formation well known in Scandinavia, North America and elsewhere in the world. In these same regions, but to a much greater extent, "remains" of quaternary glaciations are also found. Boulder-clays with typical ice-scratched boulders occur far and wide in association with fluvio-glacial gravels and sometimes with varve clay. Along numerous ancient valleys descending from the high mountains on the edge of the Kweichow plateau, and from the high ranges of western Hupeh, western Hunan and northern Kuangsi, it is possible to trace, step by step, the distribution of the vanished glaciers. With unequivocal evidence in hand, geologists and climatologists must now find a new interpretation of the cause of glaciation.

Substantial data obtained in the course of the last few years regarding the structural elements of the country shows the importance of a mesozoic movement or movements that were responsible for the general "layout" of China. The results of investigations now fully establish the fact that the broad belt of mountainous country stretching from northern Kuangsi, past western Hunan and eastern Kweichow, continues to the Yangtze Gorge area of western Hupeh. This formidable, complex range extends farther to the north-northeast forming the eastern border of the Shansi plateau, and still further north, the Great Khingan Range running between Mongolia and Manchuria. On the eastern side of this so-called Neocathaysian up-lift lies an elongated, depressed area embracing the Manchurian plain, the North China plain and the Central Yangtze Basin. Palaeontological research by members of the institute has brought out the interesting fact that this elongated basin of northeasterly trend was from time to time invaded by marine fauna in the geological past.

More recently, work has been done on the deformation of materials under strain and pressure (clay, stone, etc.) with reference to glaciation effects.

The institute unfortunately had to evacuate again during the autumn campaign of 1944, and managed to get most of its specimens and equipment back, first to the neighbourhood of Kweiyang, and now to Beipei, near Chungking. The present director is the well known geologist Dr Li Se-Kuang (J.S. Lee) and there are eight Senior Research Fellows, five Junior Research Fellows, and three Assistants Relations are maintained with the All-China Institute of Geography, which is also at Beipei.

Institute of Physics

Up to July, 1937, the institute was located in Shanghai where it had the advantage of using modern laboratory facilities which are not available in the interior. In 1938, the institute moved to Kunming; and then in October, 1940, it moved again to Liangfeng, near Kweilin, following a government order. Its re-establishment at Kweilin was completed only towards the end of 1941. In its temporary quarters, it had a magnetic laboratory, a radio laboratory, an observatory of terrestrial magnetism, and a machine shop. The shop was bombed by enemy planes in the summer of 1941 and suffered much damage. During the campaign of 1944, yet another evacuation was necessary, and the laboratories were moved back to Beipei, Chungking, not without the loss of much valuable apparatus.

While at Liangfeng, the majority of members of the institute were occupied with problems which demanded immediate attention, such as those of radio communication, making of permanent magnets, making of scientific apparatus, ore-prospecting by magnetic and electrical methods. A few members, however, still found time to carry out a survey of terrestrial magnetism in Fukien and Chiangsi provinces. While in Fukien, they had the opportunity of observing the magnetic disturbances during the total solar eclipse of September 21, 1941. Their findings substantiated the view that these magnetic disturbances were caused by the cutting off of ultra-violet radiation from the sun. The survey of terrestrial magnetism in Chiangsi province was completed in 1943, and at the same time the work was extended to Hunan province.

In the magnetic laboratory from 1942 onwards, methods for measuring the susceptibility of minerals and rocks both in powder form and in bulk form were devised and compared. Results obtained with powders of different degrees of fineness were also compared. Measurements on the variation of magnetic constants with temperature and tension for single crystals of nickel-cobalt alloys were made by Dr Shih Rju-Wei.

At Liangfeng Dr Chu-En-Lung studied properties of circuits in the radio laboratory, but the main feature of the institute was the terrestrial magnetism observatory, in which continuous self-recorded readings were obtained of all three elements by apparatus, largely made in the institute itself and housed in a non-magnetic, thermostatic building. This work was carried on by Dr Parker Chen (Chen Tsung-Chi), the companion of Sven Hedin's travels in Central Asia.

The director of the institute is Dr Ting Hsi-Ling, a distinguished literary figure as well as a physicist, who represented Academia Sinica at the Jubilee of the Moscow Academy of Sciences in 1945. There are five Senior Research Fellows, five Junior Research Fellows and four Assistants.

Institute of Mathematics

In 1941, the Council recommended that an Institute of Mathematics should be organized as soon as it could be properly equipped. But as, owing to the blockade and wartime transportation difficulties, this proved impossible, it was decided to form a group of mathematicians who should for the time being continue their work in their existing university or other posts. The present director is Dr Chiang Li-Fu of Nankai University and there are five Senior Research Fellows including Mr Chen Chien-Kung and Dr Su Bu-Chin, the geometer of Chekiang University, Dr Cheng Sheng-Shen and Dr Hua Lo-Keng of Chinghua University, and Dr Chiang Tse-Han of Peiching University. Subjects of research include theory of numbers, Fourier series, automorphic functions, geometry, projective differential geometry, higher differential geometry, and topology. Between 1942 and 1944 forty original papers were completed, and in most cases published abroad.

Institute of Chemistry

The institute is now located in Kunming where its laboratory was completed in July, 1940, with funds partly provided by the British Indemnity Fund. The first director was Dr Wang Chin, now of Chekiang University. Since the next director of the institute, Dr Chuang Chang-Kung, was unable to come to the interior, Zen Hung-Chang, secretary-general of the academy for the period 1939-40, served as director. In April, 1942, Dr Wu Hsueh-Chou was appointed to succeed him.

The work of the institute falls under three headings:

(1) Physical and Inorganic chemistry,
(2) Organic chemistry,
(3) Applied chemistry.

Since 1933, Dr Wu had been photographing and measuring the ultra-violet absorption spectra of gases. After coming to the interior, he found it impossible to continue this work for gases and had to shift to liquids and solutions. The results obtained from solutions made possible the detection of molecular structure and photochemical behaviour of compounds in their solution state. The work has so far been confined to the electronic spectra of compounds containing the carbonyl group. Mr Liu Ta-Kang has been Dr Wu's co-worker in this work, the latest publication of which was on methyl glyoxal.

Mr Liu and H. P. Chung have carefully analyzed the contents of the principal rock salt ores of Yunnan.

They found no trace of iodine by ordinary methods ; and if iodine is present, its amount must be less than eight parts per ten million. Sodium sulphate is present in the salt liquor to the extent of 13-22 per cent. By applying the phase rule to the system $NaCl-Na_2SO_4-H_2O$, it was found possible to separate out about three quarters of sodium sulphate by cooling the salt liquor to the neighbourhood of 0°C, and then further reduce the sodium sulphate content to 1-2 per cent by fractional crystallization. Another method of obtaining refined salt is to add calcium chloride to salt liquor so as to precipitate calcium sulphate. It had been suggested that the joint application of both methods would give the best and the most economical results. The separation of potassium sulphate and potassium chloride has also been effected. By successive crystallization, it has been found possible to obtain potassium carbonate of purity about 90 per cent, and then to obtain from the latter pure potassium chlorate and other potassium compounds. Pure chemicals used by Chinese chemists were formerly imported from abroad, and since foreign supply is now either cut off or difficult to obtain, home-made pure chemicals are now very much needed.

Dr Chuang Chang-Kung, former director of the institute, and his associates have made a further analysis of the Chinese drug "han feng chi". Besides the alkaloid tetrandrin $C_{38}H_{42}O_6N_2$ which had been known already, Dr Chuang found in this drug another alkaloid of composition $C_{38}H_{40}O_6N_2$, which he named demethyltetrandrin, because one OCH_3 radical of tetrandrin was replaced by an OH radical.

Dr Huang Ming-Long joined the research staff of the institute in the spring of 1941. He with Lo Chien-Pen and Miss Chu Rju-Yung has been engaged in organic synthesis. They have synthesized a series of symmetrically substituted azobenzenesulphonamides, devised an improved method of preparing N_6-acetylsulphanilamide, described a colour reaction of sulphanilamide and its derivatives containing a free amino group, and found for sulphanilamide, albucid, uliron, neo-uliron, and dagenan (either in pure state or in tablet form) a method of identification, distinct, specific, and generally applicable, which has been called the micro-acetylation method. They have also carried out synthetic work in the santonin series, and synthesized two new desmotropo-santonins, two new desmotropo-santonous acids, and the bromination products of desmotropo-santonins and desmotropo-santonous acids. One of Huang Ming-Long's pupils, Chiang Ta-Chu, has been working on the ancient Chinese anti-malarial drug "Changshan" which has recently been found in London and Chicago to possess true parasiticidal activity, though containing no alkaloid, only glucosides. Another has been working on the drug "i chi hou", an antipyretic and analgesic. There is a great field of investigation in the drugs of the traditional Chinese pharmacopoeia. We know today, for example, of antibiotics in several higher plants, to say nothing of alkaloidal drugs

Studies made in applied chemistry have included the investigation of Chinese alunite, purification and thermal treatment of castor oil, the preparation of phosphorus and phosphate fertilizers from the phosphate ores of Yunnan, the preparation of paper pulp from reeds and corn stalks, and the making of silicon iron from Yunnan minerals. The dehydration of castor oil has been thoroughly carried out, more than 20 sulphates and alums having been used as catalysts. With each catalyst, the iodine value of the dehydrated oil as well as its miscibility with mineral oils were determined. Experiments on low temperature distillation of Yunnan lignite have also been performed. The work in applied chemistry was directed by Dr Wang Hsueh-Hai and Dr Chang Ta-Yo who later on took over respectively the direction of the important wartime enterprises of the Kuanghua Low Temperature Coal Carbonization plant at Pingyi and the Lidien Low Temperature Lignite Carbonization plant at Fengmingtsun.

Under wartime conditions there are two Senior Research Fellows, two Junior Research Fellows, and seven Assistants.

Institute of Zoology

The work of the institute includes (*a*) systematic zoology, (*b*) proto-zoology, (*c*) fresh-water biology, especially of fishes, (*d*) entomology and parasitology, and (*e*) comparative physiology.

In the field of fresh-water biology, extensive ichthyological surveys have been made in the provinces of Hunan, Kuangsi, Szechuan and Sikang. Food supply and feeding habits of various edible common fishes found in Szechuan have been studied by Dr Chang Hsiao-Wei in the hope of increasing the fish supply of the province. For a most valuable edible fish *Monopterus javanensis*, detailed studies on its respiratory mechanism in both the embryonic and the adult stage have been carried out by Dr Wu Hsien-Wen and others, yielding results of particular interest. To help forward the anti-malaria campaign, a selected group of native mosquito-devouring fishes has been studied under conditions of artificial cultivation and distribution by Miss Tan Chuan-Chieh and others. Studies have also been made on Entomostraca, Protozoa, and fresh-water Algae.

In the field of entomology and parasitology, systematic studies have been carried out by Mr Chen Shih-Hsien for a beetle family, the Chrysomelidae. Observations have been made on the life history of insects injurious to horticulture. Means of natural control of parasitic round worms found in domesticated and wild animals have been investigated. Work

is proceeding on insect cytogenetics. In comparative physiology interesting investigation have been made on the gills of the paradise fish *Macropodus opercularis* by Mr Liu Chien-Kang.

Most of the research papers of the institute appear in its own periodical *Sinensia* which started publication in 1929. The 16th volume of this periodical was published in 1944. The institute which is located at Beipei has for many years been under the direction of Dr Wang Chia-Chi, the protozoologist, who has with him four Senior Research Fellows, one Junior Research Fellow and six Assistants. Close relations are maintained with the All-China Institute of Sericulture, directed by Dr Tsai Bao, at Tsunyi in Kweichow.

Institute of Botany

This institute, also at Beipei, was formed in 1944 by fission from the previously combined Institute of Zoology and Botany. Dr Lo Tsung-Lo of Chekiang University, well-known for his studies on plant growth hormones, became the new director. He has published many papers on biologically active substances such as indole-acetic acid, colchicine, auxins, trace-elements, etc.

Much work in plant science had been accomplished before the new institute was formed.

In the feld of mycology and plant pathology, a monograph on Chinese fungi, including about 2,000 species, was completed in 1938. Successful studies on the life history and methods of control of various fungus diseases affecting the tung oil tree (*Aleurites fordu*) were made. Experiments were performed on the preservation of sweet potatoes, oranges and other horticultural products.

Systematic studies were also made on the umbellate and grass families by Dr Shan Rjen-Hua and his colleagues. An extensive forest survey was carried out in Sikang province for three successive years. Particular attention was paid to the preservation of natural forests. Utilization, growth rate, and fungus diseases of economic trees were carefully noted. In collaboration with the Kansu Provincial Government, a similar survey is now in progress in that province.

Institute of Psychology

The institute first evacuated to Liangfeng, near Kweilin. Its first director had been Dr Tang Yueh ; its present director is Dr Wang Ching-Hsi. Just as the Physics Institute is mainly occupied with geophysics, especially terrestrial magnetism, so the Pscychology Institute in wartime would be better described as the Institute for Developmental Neurology. There are two Research Fellows.

Its principal work has always been in the field of physiological psychology, the subject taken up being the physiological analysis of the developmental behaviour of the tadpole. The method adopted went further than the parallel observation of the various stages in the development of behaviour with those in the growth of the nervous system. Either a part of the central nervous system of the frog embryo or of the tadpole was destroyed by surgical operation or one of the sensory organs was cut off, and the resultant changes in the development of behavior were observed. In 1940, observations were made of the normal development of the swimming and righting reflexes of the frog (*Rana guentheri*) and the effect produced upon this development by transaction of the various parts of the central nervous system before hatching. In 1841, the effect of strychnine and other drugs on the developing nervous system of the frog was studied. In the same year Mr H. T. Chu, assistant in physiology in the Army Medical College, worked in the institute and observed the ciliary movement and the circulation of the cerebro-spinal fluid in the brain ventricles of Anurans. In 1942, Dr Wang Ching-Hsi made experiments on the effect of the development of the higher nervous centers in embryo on the spinal cord. Preliminary results seemed to demonstrate that the first effect was that of inhibition. Experiments on tadpole behaviour after the reconstruction of the nervous system by the method of grafting with the embryonic nervous system were started in May, 1842, the first step being to develop a grafting and feeding technique.

Since 1941, Dr Wang Ching-Hsi has been attempting to propound a theoretical system to embrace all the reflex actions of the spinal cord as studied by Sherrington and his associates.

In the field of comparative neuro-anatomy, research has been carried out on (1) the septum of the forebrain, (2) structure of mesencephalon and rhombencephalon of the hedgehog *Erinaccus*, (3) a kind of recurrent fiber in the cerebellar cortex of the monkey, (4) nucleus of the trapezoid body in the mammalian brain, and (5) the central nervous system of Man. The first mentioned work was by Mr Lu Tze-Hui and the last three were by H. T. Chang.

In the autumn of 1944, after Dr Wang had left for a short visit to the U. S. A. and while Dr Tang was occupied with experiments on the beautiful transparent tadpoles of *Microhyla ornata*, obtainable in quantity at Liangfeng, the approach of the Japanese rendered a further evacuation necessary. The staff got away safely and have settled at Beipei near Chungking, but the move entailed the loss of the greater part of the exceptionally fine library which at Liangfeng had been housed in a specially-built brick building.

INSTITUTE OF SOCIAL SCIENCES

The work of the institute which is located at Lichuang in Szechuan has concentrated along five lines: (1) the economic history of China, (2) the problems of wartime economy in China, (3) finance, currency and trade, (4) the history of army organization, and (5) public administration. The director is Dr Tao Meng-Ho, and there are five Senior Research Fellows, five Junior Fellows, and eleven Assistants.

In the field of economic history of China, treatises on the history of land taxation in the Ming Dynasty, on the finances of the Ching Dynasty, and on the development of modern cotton industries are ready for publication. This department has been under the guidance of Dr Hsu I-Seng and Mr Yen Chung-Ping.

The National Resources Commission asked the institute to study the problems of wartime economy. Reports written by the members of the institute include those on the fluctuation of commodity prices during wartime, on a general survey of industry and currency conditions in Free China, on the economic conditions of the occupied territories and on the estimated war losses of China.

In the field of public finance studies on the financial relations between the central and provincial governments since the founding of the Chinese Republic, on district finances, on the finances of Yunnan, and on the provincial and district finances of Kuangsi have been completed. In 1942, in collaboration with the Ministry of Food, the institute sent a party of investigators to study on the spot the actual working of the new government regulations on (*a*) the payment of land taxes in kind, (*b*) government purchasing of cereals. Studies on currency problems include an estimate of silver stock in China and investigation on the finances and co-operative undertakings in the farm villages of Chekiang province. Statistics on Sino-Japanese trade in pre-war years and on the interport trade of China during 1936-40 were compiled and the evolution of international trade of China was studied.

Mr Lo Erh-Kang of the institute has chosen the history of army organization in China as his special field of study. He has written a book on the history of the Hunan Army organized by Marquis Tseng Kuo-Fan. His two manuscripts, one on the history of the "Green Barracks" and another on the army organization during the last decades of the Manchu Dynasty, are also ready for publication.

In the field of public administration, a book on the relations between provincial and district administrations in Kuangsi province is near completion.

Theoretical economics has been studied by Dr Wu Bao-Sai and Mr Fan Hung, both connected with the Cambridge School of Economics.

INSTITUTE OF HISTORY AND PHILOLOGY

Four lines of work are carried on, namely, history, archaeology, ethnology and social anthropology, and philology and linguistics. The institute possesses an extensive archaeological and ethnological collection, including a large number of treasures, such as the tortoise-shell "oracle-bone" inscriptions of the Yin dynasty from the site of Anyang; and many records of the Ching Imperial Archives. The collection of books, anthropometric records, and linguistic records in the institute is also very extensive. The situation of the institute on the banks of the Yangtze River in South-western Szechuan enabled the valuable library and records to be evacuated from Nanking direct and intact. The director of the institute is the distinguished historian Dr Fu Sse-Nien. The assistant director of the History Division is Prof. Chen Yin-Ko who has with him one Senior Research Fellow, six Junior Research Fellows, and nine Assistants. The Linguistics Division, under Dr Li Fang-Kuei, has one Senior and one Junior Research Fellow with four Assistants. Dr Li Chi heads the Archaeological Division, with three Senior Research Fellows, a Curator, three Junior Research Fellows, and three Assistants. There are also four Librarians, making a total staff of 39.

Prof. Chen Yin-Ko has now completed his treatise on the political history of the Tang dynasty. Dr Lao Kan has made a study of the bamboo inscriptions of the Han Dynasty found in the vicinity of the Gashun Nor, Ningshia, and for this work he was awarded the Yang Chüan prize of the academy in 1941. Dr Chüan Han-Sen studied the economic history of the Sung period and was awarded the Yang Chüan prize of the academy in 1942. Dr Fu Lo-Huan wrote a paper on the method of administering the various racial groups adopted by the Liao emperors. Other history section work has included the editing of the historical records of the Ming Dynasty, the editing of sources of Chin (Tartar) history, and the compilation of a critical bibliography of the astrological works of the Han Dynasty. Dr Li Kuang-Tao is studying the documents of the Imperial Archives. Work on the history of science in China is just beginning; Mr Wang Ling has written a monograph on the history of the discovery and use of gunpowder, while others have written on alchemy.

In the archaeological section of the institute, excavation reports of the following sites have been completed: Hsiaotuntsun, Liangchenchen, Houchiachuan, Sunhsien, Huihsien, Chihlihsien, and Tashihkungtsun. Reports on archaeological investigations in Suiyuan, western Szechuan, and Sikang are ready for publication. Dr Tung Tso-pin has profoundly analyzed the tortoise inscriptions of Anyang and thereby obtained a possible solution of Yin chrono-

logy as well as a knowledge of the method of calendar making adopted by the Yin people. This work, in 4 volumes, was published in 1945. The excavation of Han tombs in Pengshan, Szechuan, and archaeological investigation in the north-west, especially the study of the Buddhist paintings in the Chienfotung cave-temples at Tunhuang, Kansu, are in progress. The latter work was taken up in collaboration with the National Central Museum. A party of three experts, consisting of Dr Hsiang Ta, Dr Lao Kan, Mr Shih Chang-Rju of the institute, left Chungking for the northwest in April, 1942 and are still going on with their work.

In the field of linguistics, detailed surveys of the dialects of Hupeh, Hunan, Kueichow, Kuangsi, Sze chuan and Yunnan have been carried out by Dr Li Fang-Kuei and his assistants. A survey of Miao dialects, Tung dialects, and Tai dialects in Kueichow and Kuangsi was also carried out and a comparative study of Tai dialects was made. Prof. Chao Yuen-Rjen who had headed the section of philology and linguistics since the founding of the institute went to the U. S. A. in the autumn of 1938 to lecture at Harvard. Dr Li Fang-Kuei succeeded him.

The longer publications of the institute of history and philology appear in the form of treatises, monographs, and excavation reports, while the shorter ones appear in the periodical entitled *Bulletin of the Institute of History and Philology*. Conditions have rendered the publication of this rather erratic after the end of 1942.

Conveniently situated in the same small town are the temporary quarters of the National Museum, directed by Dr Li Chi, and of the Institute for the History of Chinese Architecture, directed by Dr Liang Se-Cheng, (son of the famous scholar Liang Chi-Chao). The museum contains recent accessions of Han bricks, stone carvings, pottery statues, bronze implements, and very interesting ancient lacquer wine bowls and boxes.

Institute of Physical Anthropology

This institute became independent of the foregoing in 1945 ; it is directed by Dr Wu Ting-Liang, assisted by two Research Fellows and a Chief Technician. It possesses a great collection of skulls from Anyang and other sites.

Before the formation of a separate institute, the principal items of work were ethnological and anthropometric investigation of the Miao people of Kueichow, and the ethnological investigation of the racial groups of western Szechuan and Sikang. Reports on the measurements of the bones of the Chinese people are ready for publication.

Institute of Engineering

In Shanghai, this institute, directed by Dr Chou Rjeng, possessed very large and modern laboratories of textile technology, glass technology, and iron and steel. On evacuation to Kunming, it found itself in an entirely different environment where the facilities for experimental work were inadequate. The two experimental plants of the institute, one on glass-making and another on steel-making, were fortunately moved to Kunming with the institute itself ; and work along these two lines could still be carried on. The plant for glass-making was bombed by enemy planes in September, 1940, but soon re-established itself in a village near Kunming. Although it has had to operate on a reduced scale, it has been able to furnish much glassware needed in medical service and in scientific work. Because of the lack of proper raw materials, the glass produced is inferior to that of former days. Unfortunately, lack of funds and support caused the glass plant to close down at the end of 1943. But the glass analytical laboratory is still working.

The equipment in the experimental plant for steel-making includes a rolling mill and electric steel furnaces. For supplying wartime needs for special kinds of steel, most of the equipment of the plant was loaned to a steel manufacturing plant some distance out of town jointly organized by the Ministry of Economic Affairs and the Yunnan Provincial Government. The members of the institute lend their technical services to this plant. This is now producing special steels of fine quality which are used also by the Allied Armies operating in the China Theatre. It also makes tool steel wire cables for the brine wells of Tzeliuching, Ni-Cr-Mo alloy piston-rings, steel for truck springs, etc. etc. There is a good metallographic laboratory at the plant and a library.

In 1941, the Central Electro-Technical Manufacturing Plant of the National Resources Commission asked the institute to make tungsten magnetic steel which was needed for telephones and electric meters. The tungsten magnetic steel produced in the laboratory of the institute has been found satisfactory, being comparable in quality with the American product. The making of cobalt magnetic steel was also attempted in 1941. The cobalt ores of Yunnan were found to contain 1.5 to 6.6 per cent cobalt oxide. From these ores, cobalt oxide of purity above 90 per cent was prepared, the remaining impurity being mainly iron oxide. This cobalt oxide can be used as the starting material for making cobalt magnetic steel.

The material testing division of the institute has carried out an extensive series of tests on Yunnan timber, including tangential and radial shrinkage,

mechanical properties, specific gravity and moisture content. For certain selected kinds of timber, dry distillation experiments have been carried out for the purpose of obtaining acetone, wood alcohol, and acetic acid.

The buildings of the institute itself adjoin those of the Chemical Institute. There are now, under wartime conditions, two Senior Research Fellows, one Junior Research Fellow and eight Assistants.

INSTITUTE OF MEDICINE

This institute, formed in 1945, is being organized by Lt. Gen. Ling Ko-Hsing (Robert Lim) and Dr Fang Teh-Fei. It is located in temporary premises adjacent to the Shanghai Medical College at Koloshan. Ultimately it will include physiology, pharmacology, biochemistry, endocrinology, etc., but it will not be possible to acquire the necessary equipment until after the war.

LETHAL TEMPERATURE OF SOME AIR-BREATHING AND NON-AIR-BREATHING FISHES OF INDIA

A. K. DAS

DEPARTMENT OF FISHERIES,
H. E. H. THE NIZAM'S GOVERNMENT, HYDERABAD (DECCAN)

INTRODUCTION

ONE of the most striking phenomenon in the life of "warm-blooded" animals generally is the remarkable constancy of the temperature maintained in spite of the variations of temperature to which they are subjected in their surroundings. When this freedom from change is contrasted with the temperature of "cold-blooded" animals, it will be seen as the one constantly changing with that of the environment, *i.e.*, these "cold-blooded" animals do not have mechanisms whereby their body can be under thermostatic control. Hence they are at the mercy of their surroundings. The present investigation was undertaken with a view to determining the lethal limit in the upper reaches of thermal conditions which these fishes can be subjected to as well as to record certain physiological changes associated with the effects of high temperature that were hitherto unknown in the thermal studies of Indian fishes.

EXPERIMENTAL TESTS

First of all four species of non-air breathing fishes were selected for the experiment, and four members from each species were subjected to experimental conditions. Excepting *Barbus* (*Puntius*) *ticto* (Ham-Buch.) they all measured about 4″ to 6.1″ in length. Similarly, four fishes from each of the four species of air-breathing fishes were taken for investigation. They were all about 4″ to 6.5″ in length. Two small glass aquaria, with a capacity of 4 gallons each, were half filled with fresh water from a large tank in the vicinity, and a batch of two fishes at a time was introduced into each of them from the non-air breathing group. The temperature of the medium was raised gradually by two degrees at an interval of 20 minutes. Exactly similar thermal treatment was meted out to the air-breathing fishes. The observation was spread over a period of several days and the experiments were performed at the same time every day. Whenever a new batch of fish was introduced in the aquaria, the water had always been replaced by fresh water and the effects of temperature were studied anew in each case, starting with the normal temperature of the medium. The effects of raised temperature on the various species of fishes and the *p*H of the medium are shown in table I and in table II.

The tables clearly show that in nearly all cases, death ensued between 39°C to 41°C. The non-air breathing fish, *Glossogobius giuris Ham-Buch*, that died at 37°C, evidently indicates that it is a very delicate fish. The *p*H at different temperatures also shows that the effect of increased temperature within comparatively narrow range interferes very little with the *p*H of the medium examined.

RECOVERY OF THE FISHES AFTER THE EXPERIMENT

Those non-air breathing fishes that over-turned in warm water and were transferred to normal fresh water (Temp. 27°C) revived within a few seconds and started moving about, darting from side to side with ease and adroitness in the course of a few minutes only. But, curiously enough, and as a great contrast, all the members of the air-breathing group that sank to the bottom, when put back into normal fresh water, overturned again and became quiet and still (Temp. 27°C).

Some of these air-breathing fishes were, however, immediately taken out of water and exposed to atmospheric fresh air or open draught (temp. 26°C), with just frequent sponging with cold water. To our great surprise, they all gradually revived after a few gulps of air between 12 minutes to 15 minutes, and when replaced again into normal fresh water which was always cold, they began, after resting for a while, swimming about with usual ease. The cold sponging undoubtedly proved highly soothing and beneficial for the recovery of these air-breathing fishes. This condition appears exactly like a typical case of pyrexia as a result of heat-stroke, and the remedy sought for here compares favourably with that followed in the treatment of human cases under such conditions.

TABLE I

EFFECTS OF TEMPERATURE AT AN INTERVAL OF 20 MINUTES IN EACH CASE

Serial No.	Species of Air-Breathing Fishes	27°C	29°C	31°C	33°C	35°C	37°C	39°C	41°C
1.	*Anabas testudineus* (Bloch)	Normal	Normal	Normal	Normal	Signs of restlessness	Very fast breathing	Breathing declined, overturned & taken out.	
2.	do.	do.	do.	do.	do.	do.	do.	do.	
3.	do.	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	
4.	do.	do.	do.	do.	do.	do.	do.	do.	
1.	*Ophicephalus punctatus* (Bloch)	do.	do.	do.	do.	do.	do.	Breathing declined.	Overturned and died.
2.	do.	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & taken out.	
3.	do.	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	
4.	do.	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	
1.	*Heteropneustes fossilis* (Bloch)	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & taken out.	
2.	do.	do.	do.	do.	do.	do.	do.	do.	
3.	do.	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	
4.	do.	do.	do.	do.	do.	do.	do.	do.	
1.	*Clarias batrachus* (Linn.)	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	
2.	do.	do.	do.	do.	do.	do.	do.	do.	
3.	do.	do.	do.	do.	do.	do.	do.	Breathing declin- Overturned and taken out.	
4.	do.	do.	do.	do.	do.	do.	do.	do.	
	*p*H Changes	8·2	8·2	8·2	8·2	8·2	8·2	8·2	8·3

CONDITION OF THE HEART AT LETHAL TEMPERATURE

A few fishes, after they were seriously affected by lethal temperature, from *both* the groups, were immediately dissected out and their hearts exposed to see whether they were beating. In every case, without exception, the heart beat had stopped. The cessation of heart beat is directly due to heat—paralysis of the myocardium or the muscles of the heart under such a thermal stress.

DISCUSSION AND CONCLUSION

The series of these experiments demonstrate that the alkalinity of the tank water which had a *p*H 8.2 showed very little change within certain range. This is probably due to the presence of stable salts in the water, which tend to have a low co-efficient of dissociation. Effect of temperature therefore, affect very little the *p*H status of such an alkaline water.

The experiments further prove that the lethal range of temperature is practically just the same for both the air-breathing and the non-air breathing fishes, although, according to Christen, time factor is of immense importance, and death may occur even at a lower temperature, provided the time of exposure is sufficiently prolonged. The frequency of

excursions to the top of the water surface, which augmented with the rise of temperature of the medium in the case of air-breathing fishes, only shows their dominant habit to aerial adaptation and atmospheric air-hunger. Such a condition finds parallel with the works of Das (1927) and Hora (1935) on the air-breathing fishes, according to which these fishes made similar efforts when subjected to asphyxiation. All the same, these individuals, however, differed fundamentally in their *physiological* behaviour, when their heart was exposed and examined *after* thermal treatment. The stopping of heart beat in all such cases reveals the fact that their *clinical* death was almost synchronous with and as complete as the physiological death. According to Das's findings in the case of asphyxiated fishes, on the other hand, physiological death of the fish followed long after their clinical death, as could be seen from the beating of the heart for several hours in certain cases. It is, therefore, quite clear that the effects of thermal death-point cause both clinical as well as physiological death in much faster succession than could be expected from mere asphyxiation.

The most interesting result of this investigation is that inspite of their absolute freedom to come up to the surface and swallow air, the air-breathing fishes could not possibly stand the heat-paralysis and failed to accomplish it. This is due to the fact that the onset of lethal temperature initiates heat-paralysis of all the tissues, the severity of which is the ultimate cause of death in both the groups of fishes. On the biochemical side, probably progressive inhibition of the uptake of oxygen by the cerebral nervous system of these fishes, following dissociation of oxyhæmoglobin as a result of high thermal stress, might be regarded as contributory factors.

Heat-paralysis of the fishes, therefore, is essentially an expression of disturbances of neuro-muscular order.

Another extremely interesting and notable feature of these experiments was that these air-breathers were more severely affected by high thermal fluctuations than the non-air breathers, and an application of cold spray coupled with exposure to draught revived the former in a few minutes. This is due to the fact that, with the fall of their body

TABLE II

EFFECTS OF TEMPERATURE AT AN INTERVAL OF 20 MINUTES IN EACH CASE

erial No.	Species of Non-Air-Breathing Fishes	27°C	29°C	31°C	33°C	35°C	37°C	39°C	41°C
1.	*Barbus (Puntius) ticlo* (Ham—Buch.)	Normal	Normal	Normal	Normal	Signs of restlessness	Very fast breathing	Breathing declined.	Overturned and taken out.
2.	do.	do.	do.	do.	do.	do.	do.	do.	do.
3.	do.	do.	do.	do.	do.	do.	do.	do.	Overturned and died.
4.	do.	do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	do.
1.	*Rasbora daniconius* (Ham—Buch.)	do.	do.	do.	do.	do.	do.	Breathing declined.	Overturned and died.
2.	do.	do.	do.	do.	do.	do.	do.	do.	do.
3.	do.	do.	do.	do.	do.	do.	do.	do.	Overturned and taken out.
4.	do.	do.	do.	do.	do.	do.	do.	do.	do.
1.	*Mystus tengara* (Ham—Buch.)	do.	do.	do.	do.	do.	do.	do.	do.
2.	do.	do.	do.	do.	do.	do.	do.	do.	Overturned and died.
3.		do.	do.	do.	do.	do.	do.	Breathing declined, overturned & died.	
4.		do.	do.	do.	do.	do.	do.	Breathing declined.	Overturned and taken out.
1.	*Glossogobius giuris*, (Ham—Buch.	do.	do.	do.	Signs of restlessness	Very fast breathing	Breathing declined, overturned and died		
2.		do.	do.	do.	do.	do.	do.		
3.		do.	do.	do.	do.	do.	Breathing declined, overturned taken out.		
4.		do.	do.	do.	do.	do.	do.		

temperature following the foregoing treatment, recovery of the neuro-muscular system takes place, and as a result, paralysis gradually disappears leading to general recovery. The principle embodying the therapeutic measures suggested for these fishes in this paper will be of immense practical value to endure the air-breathing fishes during transport over long distances in hot weather particularly and in other seasons generally.

All these facts of thermal enquiry once more prove conclusively the ingrained and prepondering susceptibilities to aerial adaptation of air breathing fishes over their non-air breathing neighbours and throw a considerable light on the necessity of their protection from unfavourable reactions to environmental changes.

The work is still in progress and other physiological details will be dealt with in a later paper to be published shortly.*

References

Adolf & Henderson, L. J., *Jour. Biol Chem., 50*, 463, 1922.
Barcroft, J., *The Respiratory Function of the Blood*, Part II, London, 1928.
Burn, D., *An Introduction to Biophysics*, London, 1929.
Das, B. K., *Phil. Trans. Roy. Soc.*, London, *216*, Ser. B, 183-219, 1927.
Field, J. 2nd, & Hale, V. B., *Ann. Rev. of Physiol. II*, 69-91, 1944.
Hora, S. L., *Trans. Nat. Inst., Sci. Ind., I*, 1-16, 1935.

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THE PROBLEM OF WATER-HYACINTH IN BENGAL

PRAPHULLA KUMAR BOSE
DEPARTMENT OF BOTANY, CALCUTTA UNIVERSITY

WATER-HYACINTH, botanically known as *Eichhornia speciosa* Kunth,* belongs to a small genus of water-plants of the family *Pontederiaceæ*. It is a native of South America, which came to be considered as a water pest and a serious menace to agriculture and navigation in Florida in 1890. It rapidly spread as a fresh water weed to countries so widely separated as Australia (Queensland) in 1895, Cochin China in 1908, Burma in 1913 and in our own Presidency in 1914, though its presence in Bengal might be traced as early as the beginning of the present century. There is no definite record to show how this plant reached this country and from what centre it spread. The records of the Herbarium of the Royal Botanic Garden at Sibpur show that it existed in this Presidency before 1902. About the year 1902-05, large quantities of the plant were seen in the railway burrow-pits near Lillooah and Dum Dum. These were very often taken out by people in or round about Calcutta for the sake of the elegant beauty of the lilac flowers. It is reported that in 1905-06 this plant was first introduced to Eastern Bengal by a certain gentleman who carried a few plants from Calcutta and placed them in his own tank at Narayangunge for the sake of the flowers. This tank was overgrown in course of a year and the surrounding area was soon infested. Thus within a very short space of time, the plant multiplied and spread to such an extent as to be a most serious economic problem to the whole country and continues to remain a problem of much embarassment in this 'problem-ridden province of Bengal'. Since this pest first made its appearance in this province more than three decades ago, it has spread with such profusion over the waterways with its habitual rapidity as to constitute a serious menace not only to agriculture and fishery, but to her internal communications blocking up navigable waterways, and interfering with drainage channels and, what is more, to the health of the rural population. The water-hyacinth has thus become a problem that touches the life of the province at so many vital points. The pest of water-hyacinth has been the cause of crop-damage in Bengal to the tune of huge sums of money and every year crops and fish worth crores of rupees are destroyed by this pest alone. The necessity of keeping this noxious water weed under control so as to prevent these serious results, although very difficult, is a very urgent matter for the welfare and prosperity of the country.

In 1914, the Narayangunge Chamber of Commerce in Eastern Bengal brought to the notice of the Local Government the dangerous nature of the pest and finally in, 1925 the Associated Chamber of Commerce in India and Ceylon urged the Government to introduce legislation for eradication of the pest. It was only in June, 1921 that a Water-Hyacinth Com-

* It is believed that the genus was named after a German Minister who lived about the end of the 18th century, which goes to show that the plant already existed about that time.

mittee under the Chairmanship of our illustrious country man the late Sir Jagadish Chandra Bose was appointed to investigate the whole question, particularly the problem of eradication. This Committee *inter alia* made suggestions for legislative measures: but so far the history of legislation in different countries has not been encouraging. In 1936, the Bengal Water-Hyacinth Act was passed and subsequently an amendment (1940) was added to tighten up the provisions of this Act. Nevertheless this "beautiful blue devil" refused to be intimidated.

The solution of the problem of water-hyacinth has undoubtedly a very significant bearing on the success of the "Grow More Food" campaign and as such the question of eradication of the pest ought to press itself on the attention of the Government of Bengal as of vital importance and urgency in the Post-war scheme for the rehabilitation of Bengal. The normal annual yield of rice in Bengal is roughly about 80 to 85 lakh tons, which is hopelessly inadequate to feed nearly seven crores of Bengal's own population. This water weed has a definite retarding influence on the paddy cultivation, and naturally this loss to the already small and insufficient yield of paddy in our province cannot and should not be ignored. There is an area of about 37½ lakh acres of cultivable waste lands in Bengal, a greater portion of which is lying covered with water-hyacinth, particularly in Lower Bengal,—commonly known as the deltaic portion. Moreover, this water pest has very much affected the development of inland fisheries causing shortage of fish which is one of the chief and indispensable items of Bengal's normal dietary. With the advent of the economic depression and the acute shortage of food, a change has very happily come over the outlook of the rural population and a spirit of self-help and mutual help has manifested itself amongst the general public in rural areas. With substantial contributions from the Central Government to give a push to the "Grow More Food" campaign, the present seems to be the most opportune time for launching an organized drive against the pest and also to teach the cultivators how to conserve and prepare manure and compost from it for soil enrichment.

The water-hyacinth plant is highly resistant and so far no member of the animal and plant kingdoms has yet been discovered which would promise to act as a check on the growth of the water-hyacinth. An alga common in stagnant pools and back waters (*Tribonema bombycinum Ag*) is very often found to be closely entangled with the bunches of rootlets of the plant and appears to affect its normal healthy growth, but it does not kill the plant, and even if it did so, the remedy might prove worse than the disease itself.

Two chemical substances have been found to be very effective in killing the water-hyacinth, namely common salt and sulphuric acid. When placed in a 5 per cent solution of common salt in ordinary pond water the plants show signs of decay in 24 hours and is completely killed in 5 days, in 1 per cent solution it dies in 10 days, and in 0.5 per cent solution in 16 days. A 10 per cent solution kills the pest in a very short time, but the application of this remedy over an extended area would require immense quantities of rock or sea salt. Moreover, the effect is rather uncertain, as parts of the stem may escape destruction.

The water-hyacinth is an alkali-loving plant, as indicated by the indigo colour of the rootlets and any mineral acid will therefore act deleteriously on the water pest. Thus sulphuric acid, which can be transported easily, has been found suitable. Very dilute solution of this acid is not injurious to the health of cattle and man, and is, in fact, a preventive of cholera. It attacks lead only slightly and an alloy of lead and antimony is nearly immune to corrosion by the strong acid. It would not be difficult to design an efficient spraying apparatus of those alloys; but the application of these or any other chemical remedies over an extended area would offer immense difficulties. Any such type of specially designed spray may be useful only in facilitating removal of the water-hyacinth to the borders of pools, tanks and all other watercourses, but are not likely to lead to a total eradication of the pest. The spraying of patches with arsenical solutions, though efficacious, if thoroughly done, would be too expensive and are likely to produce results not originally contemplated, and their application is quite out of question where village tanks are concerned, for obvious reasons and must therefore be altogether avoided. Similarly, poisons of such deadly potency cannot be employed in watercourses through inhabited areas, and where the people cultivate fish as means of livelihood. Moreover, whether poisonous or not, the first application, even if efficacious, may not be thorough enough as to preclude the possibility of some surviving plant, or portion of a plant, or a stolon, remaining to develop and to become in a short space of time as great a nuisance as it was in the beginning. This fact is more important, if we bear in mind that reproduction of the plant is also effected by seeds, which fall into the water when ripe and are then freely distributed giving rise to new seedlings after a period of desiccation. Even if any chemical or thermal process does kill the plant, there will always remain the problem of its removal for it would not do to cover immense areas with rotting vegetation; the latter will have to be removed ultimately by mechanical methods and handpower.

The late Sir J. C. Bose (Vide "*Transactions of*

Bose Institute, Vols. III & IV, pp. 786-795, 1923) after giving the details of his own experiments and observations on the pest and the various possible methods of eradication, arrived at the inevitable conclusion the "the only effective means is in the mechanical collection and destruction." Similarly, Prof. Parija of Cuttack published (*The Ind. Journ. of Agri. Sc.*, Vol. IV, Part III of June, 1934) a very interesting account of the work done by him on the Physiological investigations on Water-Hyacinth in Orissa, financed by the Imperial Council of Agricultural Research. A careful perusal of this valuable work shows that the learned Professor had very minutely examined the various methods of eradication of the pest and finally came to the conclusion that the best method of getting rid of this pest finds nothing better than man-handling the plants, all other methods proving either ineffective or unsatisfactory. The writer has always advocated that man-handling and other mechanical methods must play a considerable part in any successful empaign for eradication of the plant—the biological or chemical and thermal methods proving either uncertain or inadequate.

A very recent report shows how certain American scientists have succeeded in clearing, by a very ingenious method, certain localities in the United States which had been plagued by a similar noxious water plant (Water chestnut or Caltrop,—Botanically known as *Trapa bispinosa* Roxb), for a pretty long time, by designing and employing a very simple type of a cutting machine. It is said that "When King George and Queen Elizabeth were to be taken to Mount Vernon for a visit by boat, considerable effort had to be made to dredge the channel and clear away the water chestnut so that Mount Vernon landing could be approached. About five years ago President Roosevelt made a cruise down the river with the then Secretary of Agriculture, Henry A. Wallace in the party. The President wondered if some use could not be made of the dense vegetation and the Department of Agriculture made experiments to see if it could be utilized as fertilizer." A small cutting machine was finally designed and developed which was successfully employed to do clean-up work in the affected area. "The eradication of the water chestnut, or caltrop has been a truly remarkable accomplishment. The elimination of this pest which had virtually taken possession of the river for 40 miles is complete, except that there will have to be careful watching for a few years to come to see that the plant is not allowed to re-establish itself." The report further adds, "The final defeat of this foreign enemy which was rapidly ruining one of America's most beautiful river is a glowing tribute to engineering and mechanical skill. In its last analysis it was a mechanical victory in which effective instruments were devised by which approximately 10,000 acres of waters were moved as a farmer would mow his hayfield and the seeds of the noxious plant were destroyed." The same report concludes that the new type of equipment designed to cope with the water chestnut problems "holds out a promise that similar machinery may be developed to eradicate noxious plants in other areas which are choking out plant food essential for waterfowls and game fish in mill ponds, lakes and streams in many sections of the country." It may similarly be said that the water-hyacinth by its dense vegetation and highly absorbing power of its innumerable small fibre-like rootlets, has already more or less displaced many aquatic grasses which were once so characteristic of Bengal's deep-water paddy fields. This has seriously interfered with the botanical studies of grasses growing in paddy fields and, what is even more important from an economical point of view, it has deprived the cattle of some of the best varieties of aquatic fodder during the rains. Owing to the scarcity of grass in thickly populated areas, where sufficient grazing grounds are not available and in villages and *bil* areas where the more common aquatic weeds hitherto utilized as staple fodder having been annihilated by the water-hyacinth, the cattle is forced to feed on the leaves of the latter which with more than 90 per cent of water in its constitution is only a poor substitute for the more nutritive grasses and consequently the quality of milk has very much deteriorated and the general health of the cattle fed on water-hyacinth has greatly run down.

The only effective means of dealing with the evil, therefore appear to be *the mechanical means—human and machinery*. That will undoubtedly involve strenuous, concerted and consistent labour applied over a number of years. The best time for collection of the water-hyacinth is during the months of October to March. Floating plants are comparatively easily dealt with, while their collection is most difficult, if, after the water has gone down, they have taken firm root in the mud. When dragging the plants on land, care must be taken to drag them to a high enough level to prevent water reaching them when the monsoon rains set in. Merely dragging the plants to the water's edge is worse than useless. All these facts emphasize the point that it is very important and essential that the main campaign of operational work should be placed in charge of real experts in the problem who must possess a very intimate knowledge of the subject matter at issue, particularly regarding the life-history of the plant, how it grows and thrives and above all, how it spreads, and who are also capable to give an energetic drive to this difficult task which would surely require a good deal of tact and resourcefulness to make the whole campaign successful.

As a potash plant the water-hyacinth is a useful

manure, either green or dry. It is a well known fact that fresh specimens of the plant contains more than ninety per cent of water and as such a ton of the fresh water weed contains about eighteen and a half cwt. of water. Again, a ton of the fresh weed yields less than a cwt. of the thoroughly sun-dried stuff. It is, therefore, more advantageous to use the sun-dried plant directly as a potash manure than to burn the dried stuff and use the resulting ash. More because, it has been found that the manurial value of the rotten plants buried under earth and made into a compost is greater than the ash derived from the burning plant. All water-hyacinth plants must be pulled out from the places where they are growing and piled up on some adjoining high lands for proper disposal, either by fire or burying them down in pits dug out in grounds for this purpose; this method will be found to be of general application. The pits when full should be covered with a layer of earth or sand. If the pit method of disposal be adopted, it is recommended that a little quick-lime be thrown in with the plants to accelerate decomposition.

An American author in an article on "Water-Hyacinth, a foe or friend", published in the "Aquarium", June, 1944 while describing water-hyacinth as "one of the popular plants used for spawning" says, "It would be difficult to imagine a plant more variously regarded than the water-hyacinth. In some of our southern streams it is detested because in its prolific growth it actually obstructs navigation. Great expense is entailed in periodically clearing it out. In the spring it is highly esteemed by Goldfish fanciers as a medium for catching the eggs of spawning fishes. It is frequently used also for spawning tropicals which have adhesive eggs, such as *Danio malabaricus*. The finely divided, thick-branching, blue-black roots form an ideal mat for the fish to rub again and deposit their eggs on passing. Floating, as they do, is an advantage. The plants, with eggs attached, are easily lifted out. Furthermore, many such fishes like to spawn near the surface, Goldfishes coming partly out of the water during their frenzied action at breeding time. The high regard of the fish breeder for the water-hyacinth commences to cool as summer passes, for he not only does not know what to do with his increased stock, but usually is unable to keep even a few breeder plant over the winter, since they require strong light, heat and moist atmosphere. Repetition never quite seems to dull the painful October act of throwing a bushel of plants that would be worth good money in the spring if they could only be saved."

It is not known if any similar phenomenon has been observed and recorded by those who are engaged in the investigations of either rearing or breeding of fishes in Bengal, especially of those types that are indigenous to inland waters. But so far the various reports of fish mortalities in stagnant pools and ponds covered with water-hyacinth at once dispel the ideas and also ruin the prospect that the water-hyacinth should ever be fancied in tropical countries as "one of the popular plants" for any kind of pisciculture.

It is already a common knowledge that the water-hyacinth is a tropical plant which can hardly stand severe frosts and as such the temperate regions are more or less free from this pest.

It may be mentioned that the Government of Bengal tried to assail the water-hyacinth from time to time in a variety of ways, but so far failed to produce any enduring effect—the reason of its failure every time was mainly due to *lack of any definite plan of action and sustained work.* The solution of the problem of water-hyacinth is of such great complexity and difficulty that haphazard and half-hearted measures are not adequate for a problem of such magnitude and therefore, any piecemeal or short-cut method is bound to be unsuccessful. The Government of Bengal ought to realize by now that their long apathy to tackle this water weed more effectively, has already allowed the pest to do a good deal of mischief in the countrysides by devouring and devastating the agriculture of the province and also ruining the health and prosperity of rural Bengal. It is therefore hoped that the Government would take immediate and suitable steps to initiate a vigorous and well-directed campaign to educate the people in all useful knowledge regarding this plant, so that public opinion can be sufficiently aroused to tackle this national problem. In this important task, it is suggested that the British Indian Association, whose membership includes the most influential landowners of Bengal, the different Chambers of Commerce and all other public and voluntary organizations should be invited by the Government to come forward and meet at a representative conference to take early steps and chalk out a constructive programme for devising suitable means of fighting out this national danger by enlisting the co-operation of all who have the welfare of the country at heart. There are many young self-less workers in our country, who are always ready to render some useful service to the welfare of his or her society or nation, but it is also plain that for lack of any suitable organization and a true ideology such latent desires to do anything substantial can never be fulfilled. Let the Government prove their earnestness in this matter and create an atmosphere in which it would be possible for all sections of the community to work together.

The extermination of this weed has to be undertaken on a mass scale, but efforts towards developing a mass movement have thus far been very feeble, possibly because of the fact that there is hardly any special charm in the task of uneconomic eradication

It would probably be more energetic if some suitable return could be obtained for the labour involved in the task of clearing the pest. But, unfortunately enough the green water-hyacinth plant contains about 95 per cent. of water and as such it is highly doubtful if any useful commercial product can be obtained from the remaining 5 per cent of other materials in the plant for purposes of industrial utilization. The distribution of potassium occurs in all parts of the plants, although in somewhat varying quantities. The green plant gives 1 per cent of ash. The ash contains 28·7 per cent of potash salt. Actual trials to obtain potash from the plants on a large scale for commercial purposes have proved abortive owing to the costliness. Numerous starch grains are found in the cells of the stem during the cold season, but these grains disappear as the cold season advances. The extraction is, therefore, definitely unprofitable. The suggestion to manufacture paper from the dry pulp has been found unprofitable on account of the inferior quality of the pulp. The claims of the Industries Department of the Government of Bengal on the profitable utilization of water-hyacinth in the manufacture of wrapping papers and preparation of plastics out of the weed will undoubtedly raise some hopes which, let us hope, may not ultimately prove illusory when we come to consider the total cost of collection, drying, transport and actual process of manufacture. It is yet to be seen whether what has been possible to prepare in the laboratory can ever profitably make its way in the market as a suitable commodity of trade. The green manure obtained by composting the water-hyacinth plants has been found to be eminently suitable for jute and rice fields, in gardening and fruit growing and this useful manure can be very well prepared at a very negligible cost.

In conclusion, I feel certain that such commendable co-operative effort of the people of Bengal—both officials and non-officials, is bound to inspire confidence in the hearts of those who despaired of any success in tackling this formidable problem by manhandling and other suitable mechanical methods and this will further afford an object lesson of what can be achieved by the combined and well-directed efforts of all people irrespective of any caste or creed. It is finally hoped that right-minded people of every section in Bengal will realize the gravity of the situation and start afresh to work together so that the delinquents may also take heart. I believe this is possible and ought to be tried. It is very necessary that as soon as Bengal starts to tackle the problem, Assam will have to clear out the pest. If Bengal starts work without Assam joining hands at the same time, Bengal will certainly be re-infected through down currents of Brahmaputra and the pest will be redistributed all over Bengal.

STANDARDISATION AND QUALITY CONTROL IN INDUSTRY

(MRS) CHAMELI BOSE,

STATISTICAL LABORATORY, CALCUTTA

LARGE scale production consists in almost infinite repetition of phenomenon, the production of the same article over and over again. But, in spite of the thoroughness of the machines and the technical skill of the operator, and the great care with which the management execute their work, it is impossible to achieve the complete sameness of the manufactured products. Even if the quality of the raw material was maintained fairly level, numerous factors such as temperature, humidity, degree of stirring etc. can only be partially controlled and the result is that the product varies in quality and form. For example, the tensile strength of the malleable iron casting, the breaking strength of cloth and those of the railway axle, or of cement, the linear dimensions of shaft, diameter of steel bolts etc. all these qualities and forms depend on the exactness of the process through which these are manufactured. In all these cases the "test results" will not be found to be identical and the differences between them are not merely due to errors in measurements but to want of sameness in the articles themselves. The sources of these errors are two ; one is due to some systematic causes (in statistics these are called assignable causes) and the other is due to some unavoidable causes which are beyond human power to control.

The following is a very simple example illustrating the above fact, given by Dr Walter Shewhart (of the Bell Telephone Company of New York) one of the foremost pioneers in the application of statistical

science to industrial standardisation and quality control.

"Write the letter "a" on a piece of paper. Now make another "a" just like the first one; then another and another until you have a series of a's a, a, ... You try to make all the a's alike but you don't; you can't. You are willing to accept this as an empirically established fact. But what of it? Let us see just what this means in respect of control. Why can we not do a simple thing like making all the a's just alike? Your answer leads to a generalisation which all of us are perhaps willing to accept. It is that there are many causes of variability among the a's, the paper was not smooth, the lead in the pencil was not uniform, and the unavoidable variability in your external surroundings reacted upon you to introduce variations in the a's. But are these the only causes of variability in the a's? Probably not.

We accept our human limitations and say that very likely there are many other factors. If we could but name all the reasons why we cannot make the a's alike, we would most assuredly have a better understanding of a certain part of nature than we now have. Of course, this conception of what it means to be able to do what we want to do is not new; it does not belong exclusively to any one field of human thought; it is commonly accepted. The point to be made in this simple illustration is that we are limited in doing what we want to do; that to do what we set out to do, even in so simple a thing as making a's that are alike, requires almost infinite knowledge compared with that which we now possess. It follows, therefore, since we are thus willing to accept as axiomatic that we cannot do what we want to do and cannot hope to understand why we cannot, that we must also accept as axiomatic that a controlled quality will not be a constant quality. Instead, a controlled quality must be a variable quality. This is the first characteristic.

But let us go back to the results of the experiment on the a's and we shall find out something more about control. Your a's are different from my a's; there is something about your a's that makes them yours and something about my a's that makes them mine. True not all of your a's are alike. Neither are all of my a's alike. Each group of a's varies within a certain range and yet each group is distinguishable from the others. This distinguishable and, as it were, constant variability within limits is the second characteristic of control."

Similar things happen in industrial production of manufactured goods. For example test results of the breaking strength of malleable iron casting are likely to vary from specimen to specimen within the same batch and also from batch to batch even if special care were taken in the selection of raw material, and in the maintenance of machines. These variations of the quality of malleable iron casting depend on many known factors such as homogenisation of mixture, control of temperature, avoidance of accidental chilling etc. If routine test results during the process of manufacture are recorded systematically, then causes of variation in quality can be statistically investigated, leading possibly to an elimination of at least some of them which are distinguishable.

It may be that in the course of routine production repeated tests of quality are carried out by manufacturers but the question is whether they are used to the best advantage for serving the purpose of control in which they are interested. Sometimes it is not possible to carry out routine tests of quality due to the destructive property of the test, and even where it is possible, it is obviously uneconomical to carry out extensive checking of the quality of products which is the routine method followed by the Government Test Houses in India. With the help of modern statistical science an estimate of the whole batch of consignment can be obtained by checking only a part.

In England the interest created in the application of statistics to industrial products dates from some lectures given in London in May 1932, by Dr Shewhart. In England and U. S. A. considerable progress in many directions has been made in this subject. In 1933, the Council of the Royal Statistical Society set up a Committee consisting of statisticians including Dr E. S. Pearson, an eminent statistician, and other technical experts for formulating the scheme of working in this special branch of applied science.

Large scale Indian industry is likely to thrive considerably during the period of post-war reconstruction and to increase the efficiency of such concerns it is necessary to establish close co-operation between statisticians and technicians. The Board of Industrial and Scientific Research at Delhi has set up a Committee consisting of statisticians and industrialists for consideration of the problems involved in standardisation and quality control of industrial products. The formation of this Special Committee definitely satisfies a longfelt want. A course of training in this subject initiated by the above Board has already started at the Indian Statistical Institute, Calcutta.

Specification: A very common and essential problem in industry is to secure conformity to specification. It has been already mentioned that the product will never be uniform, but will vary within a certain range about an average value. It must be recognised that this is inevitable, however efficient the control of production might be. It is not, therefore, sufficient to specify only average values, but it is necessary also to indicate the permissible variation about such averages.

The consumer sometimes wants that the variation should fall within certain limits; sometimes he can allow greater latitude provided that a certain minimum level is attained; and sometimes he is not so much concerned with the precise average level, provided this level remains constant from one consignment to another. All these depend on the type of specification needed.

For the purpose of securing conformity to specification two methods are generally used.

(1) What is commonly known as "consignment sampling" in which samples are taken from finished products either at random or by a special choice.

(2) The second method which operates during the process of manufacture and which may conveniently be called process sampling, consists in keeping records that will provide statistical evidence of the level of control during the process of manufacture.

The first method is very expensive and hence the second method (which is much more economical and technically as effective) is adopted. The advantages of the second method are the following:—

(1) It avoids the difficulty of drawing a representative sample.

(2) It dispenses with large scale sampling which would be otherwise needed to give adequate assurance to the consumer.

(3) It ensures that the control during different stages in production remains effective. It should be noted in this connection that to increase the efficiency of production processes it is necessary to remove the defective material at some of the initial stages in production rather than let it pass on to the final stage where it would most likely cause the rejection of a finished unit of product.

Sampling: Closely related to the question of specification is that of sampling. How many tests are necessary for a given degree of accuracy? How should the units in the samples be chosen? These are the points which involve statistical investigation of the extent and nature of the variations among different units of the material in question. There may be variations within a unit, between units in the same consignment, between different consignments from one source of supply, between sources of supply, and between batches supplied at different seasons; it will then be seen that the problem is in general very complex, and may involve a highly specialised statistical technique as well as a technical knowledge. Clearly, at this stage sound judgment, coupled with a knowledge of the production process, is needed as distinct from a mere knowledge of the statistical technique.

It will be necessary, too, to take into account both statistical principles and technical considerations in deciding on the degree of accuracy or (uniformity) that is to be required of a specification. The more accurate the specification, the greater would be the cost of testing, for larger samples would be required. Now if the sampling process were repeated, the measures would vary from one sample to another, and the only method of assessing this variation and determining the reliability of the estimate obtained from a single sample is the statistical method.

Control of quality: It has been mentioned before that if the variation among the individual units is considerable then it may be an impracticable proposition for consumer to test sufficient individual articles to give him the desired degree of information regarding the consignment. Therefore the evidence that the definite methods of statistical analysis are applied by the producer during the process of manufacture to assess the level of his control of quality is needed. This evidence coupled with check tests of the finished product on a smaller scale (than what would be required if finished products alone were sampled and tested) satisfies the specific needs of the consumer. Moreover, this procedure of maintaining control of quality during manufacture helps the producer in improving the efficiency of production.

Research in Industry: In England and America a large part of the work of the scientists in industry consists in conducting experiments to find the effect of variation in one factor on another. A research laboratory is attached to most of the important industrial concerns to increase the efficiency of British Industry both as regards its quality and quantity. Statistical principles are utilised in designing the experiment to be conducted in the laboratory.

In India unfortunately the efficiency of industrial production is definitely below par. In order to hold its own against international competition which is bound to be more acute in the near future, she must adopt recognised scientific methods and initiate scientific researches in every important industrial concern. Statistical help in this respect is essential for planning of experiments.

PROFESSOR J. N. MUKHERJEE

WE have great satisfaction to record the news of the appointment of Dr J. N. Mukherjee, D.Sc., F.N.I., C.B.E., Ghose Professor of Chemistry, University College of Science, Calcutta, as Director of the Imperial Agricultural Research Institute, New Delhi, in succession to Rao Bahadur B. Viswa Nath, the former Director. We understand that Prof. Mukherjee will join his new post from the middle of October, 1945.

Prof. Mukherjee is a distinguished chemist of India and has established international reputation in the field of physical chemistry, particularly in colloid chemistry and soil science.

After obtaining the Master's Degree in Chemistry in 1915, Mr J. N. Mukherjee and Mr (now Sir) J. C. Ghosh joined in September of the same year the newly established University College of Science as Assistants to the Palit Professor of Chemistry, the late Sir (then Dr) P. C. Ray. In 1917, when the Post-Graduate classes in Chemistry of the University of Calcutta were organised, he became a Lecturer in Chemistry. In 1919 he went on a study leave to London and worked in the University College in the



PROF. J. N. MUKHERJEE

laboratory of Professor F. G. Donnan, C.B.E., F.R.S. and was awarded the Degree of Doctor of Science of the University of London in 1921. On his return to India in 1921, he was appointed the Guruprasad Singh Professor of Chemistry of the University of Calcutta and in 1937 he became the Ghose Professor of Chemistry of the University. He has thus been associated with the University College of Science for almost exactly thirty years.

He began his researches on colloids in 1914 while he was a student in the Presidency College, Calcutta, thus initiating researches in this subject in India. His researches mostly lie in the field of colloids, especially the electrochemistry of colloids, and he is considered to be one of the foremost workers in this field. The late Professor R. Zsigmondy, Nobel prize winner and discoverer of the ultramicroscope, in his well known text book on colloids wrote that along with Bredig, Michaelis Fajans and Freundlich, he (Mukherjee) is one of the builders of this subject. Professor Mukherjee has built up, as is well known, an active school of research in Physical Chemistry, Colloids and Soil Science in the University of Calcutta. Amongst those of his students and collaborators who have made fundamental contributions in their respective branches are Dr S. G. Chaudhury, Dr S. K. Majumdar, Dr B. N. Ghosh, Dr K. Krishnamurti, Dr J. K. Basu, Mr S. N. Mukherjee, Dr S. P. Raychaudhuri, Dr R. P. Mitra, Dr B. Chatterjee, Dr N. C. Sen Gupta, Mr S. K. Mukherjee, Dr H. K. Acharya, Dr N. P. Datta, Mr M. K. Indra, Mr. B. R. Majumdar and others.

In appreciation of his scientific work on certain fundamental problems relating to the production of oil, the Burmah Oil Company made a donation of Rupees thirtyfive thousand, which has been utilised for building the Colloid Research Laboratory in the University College of Science, and the University granted an equal amount for its equipment.

He has been actively associated with the foundation and development of a large number of scientific organisations in the country, such as the Indian Chemical Society, the Indian Society of Soil Science, the Indian Science Congress Association, the National Institute of Sciences of India and the Indian Association for the Cultivation of Science.

In 1935 he attended the Third Congress of the International Society of Soil Science as the leader of the Indian delegation. He has been a member of the Soil Science Committee of the Imperial Council of Agricultural Research since its foundation and is a member of the Policy Committee on Agriculture and Forestry of the Reconstruction Committee of the Viceroy's Council and of many other scientific committees of the Central Government, Government of Bengal and other bodies. He has wide experience of administration, financial and otherwise, of educational and scientific bodies.

He was one of the members of the Indian Scientific Mission that recently visited the U. K., the U. S. A., and Canada.

He was created a C. B. E. in 1943.

Notes and News

EXCERPTS FROM PRESIDENT TRUMAN'S REPORT ON THE ATOMIC BOMB

THE following excerpts from the report of President Truman on the Atomic Bomb submitted before the American nation immediately after its use against the Japanese put on record the great efforts made to harness the nuclear energy for destructive purposes and her attitude towards its utilization in war and in peace.

"Sixteen hours ago an American airplane dropped one bomb on Hiroshima, an important Japanese army base. That bomb had more power than 20,000 tons of TNT. It had more than 2,000 times the blast power of the British 'Grand Slam', which is the largest bomb ever yet used in the history of warfare. * * *

It is an atomic bomb. It is a harnessing of the basic power of the universe. The force from which the sun draws its power has been loosed against those who brought war to the Far East.

Before 1939, it was the accepted belief of scientists that it was theoretically possible to release atomic energy. But no one knew any practical method of doing it.

By 1942, however, we knew that the Germans were working feverishly to find a way to add atomic energy to the other engines of war with which they hoped to enslave the world. But they failed. * * *

Beginning in 1940, before Pearl Harbor, scientific knowledge useful in war was pooled between the United States and Great Britain, and many priceless helps to our victories have come from that arrangement. Under the general policy the research on the atomic bomb was begun. With American and British scientists working together we entered the race of discovery against the Germans.

The United States had available the large number of scientists of distinction in the many needed areas of knowledge. It had the tremendous industrial and financial resources necessary for the project and they could be devoted to it without undue impairment of other vital war work.

In the United States the laboratory work and the production plants, on which a substantial start had already been made, would be out of reach of enemy bombing, while at that time Britain was exposed to constant air attack and was still threatened with the possibility of invasion.

For these reasons Prime Minister Churchill and President Roosevelt agreed that it was wise to carry on the project here. We now have two great plants and many lesser works devoted to the production of atomic power. Employment during peak construction numbered 125,000 and over 65,000 individuals are even now engaged in operating the plants. Many have worked there for 2½ years. Few know what they have been producing. They see great quantities of material going in and they see nothing coming out of these plants, for the physical size of the explosive charge is exceedingly small.

We have spent $2,000,000,000 on the greatest scientific gamble in history and won.

But the greatest marvel is not the size of the enterprise, its secrecy or its cost, but the achievement of scientific brains in putting together infinitely complex pieces of knowledge held by many men in different fields of science into a workable plan. And hardly less marvellous has been the capacity of industry to design, and of labor to operate, the machines and methods to do things never done before so that the brain child of many minds came forth in physical shape and performed as it was supposed to do. * * *

It is doubtful if such another combination could be got together in the world. What has been done is the greatest achievement of organized science in history. It was done under high pressure and without failure.

We are now prepared to obliterate more rapidly and completely every productive enterprise the Japanese have above ground in any city. We shall destroy their docks, their factories and their communications. Let there be no mistake; we shall completely destroy Japan's power to make war. * * *

The fact that we can release atomic energy ushers in a new era in man's understanding of nature's forces. Atomic energy may in the future supplement the power that now comes from coal, oil and falling water, but at present it can not be produced on a basis to compete with them commercially. Before that comes there must be a long period of intensive research.

It has never been the habit of the scientists of this country or the policy of this Government to withhold from the world scientific knowledge. Normally, therefore, everything about the work with atomic energy would be made public.

But under present circumstances it is not intended to divulge the technical processes of production

or all the military applications, pending further examination of possible methods of protecting us and the rest of the world from the danger of sudden destruction.

I shall recommend that the Congress of the United States consider promptly the establishment of an appropriate commission to control the production and use of atomic power within the United States. I shall give further consideration and make further recommendations to the Congress as to how atomic power can become a powerful and forceful influence towards the maintenance of world peace."

The triumphant tone of President Truman in his country's ability to almost wipe out of existence two industrial and important cities of Japan makes a sad reading. The development of a process with which to utilize the nuclear energy certainly marks a new era in the history of science, but its thoughtless use against millions of peaceful civil population, with such widespread slaughter, confounds humanity today. Recently Prof M. L. Oliphant, of Birmingham University, strongly condemned the way in which the bomb had been used. The bomb, according to him, should not have been dropped on a city ; one of the islands of Tokyo Bay used as a normal base should have been wiped out instead, after intensive propaganda warnings.

It is highly improbable that the United States would be long able to enjoy the privileged position now derived from her control of the secrets of atomic bomb. Only the other day Marshal Stalin asked the Soviet scientists to pool all scientific and technical resources to manufacture the bomb. Prof Oliphant believes that any industrial country can have the bomb in five years and any determined industrial country in two years.

It is for this reason that the cessation of hostilities has not filled humanity with fresh hope, security and inspiration.

DAMODAR VALLEY PROJECT

A NUMBER of important decisions with regard to the unified and multi-purpose Damodar Valley Development project were taken at a conference between the Central Government and the Governments of Bengal and Bihar, held at Calcutta towards the end of August, and presided over by the Hon'ble Dr B. R. Ambedkar, Labour Member to the Government of India. It was agreed that the scheme should provide the maximum measure of flood control. The conference discussed the technical aspects connected with the three dam sites at Aiyar and Sonalapur on the Damodar River and at Maithon on the Barakar, suggested so far, and decided that further investigations were necessary before starting actual construction work. The Central Technical Power Board has been authorized to prepare project reports for each of these dam sites and has been instructed, in the case of Sonalapur, to deal with possible effects on coal production. The Central Government would provide the necessary staff to carry out further investigations under the technical direction of the Board.

It was decided that the Government should invite four American engineers to advise on the design and construction of the dams early next year, by which time the required data are expected to be collected.

It was already agreed upon that the administration of the project would be finally vested in a Damodar Valley Authority to be constituted after the model of the T. V. A. During the interim period, however, a high ranking administrative officer would be appointed to co-ordinate all preliminary action and for expediting investigations connected with the proposed project.

Investigation on the dam sites should have in view not only flood control, but all allied problems of a river in harness, such as the utilization of the water for irrigation, development of power including setting up of nursery stations, anti-erosion works, navigational, geological and water supply aspects of the scheme and the layout of transmission lines.

CENTRAL TECHNICAL POWER BOARD'S RECOMMENDATIONS

The Central Technical Power Board, in pursuance of a resolution adopted at the conference held in January, and already reported in SCIENCE AND CULTURE (Vol. X, No. 8), prepared a preliminary memorandum recommending the construction of a series of reservoirs providing flood control, irrigation, hydro-electric power and thermal power stations interconnected by transmission lines. The Board suggests the building of a system of eight dams and a barrage, of which seven dams will be used for hydro-electric purposes. All of these will, however, be provided with hydro-electric generating plant. The aggregate controlled reservoir capacity would be about 4,700,000 acre-feet. The amount of reservoir capacity, reserved for flood control purposes, would reduce the maximum design flood to a flow of about 250,000 cusecs at Rhondia.

The plan would provide for perennial irrigation of about 760,000 acres, including the 186,000 acres now partially irrigated. It will also make available ample supply of water for domestic and industrial purposes.

Studies indicate that the combined development should make available about 65,000 continuous kilowatts of primary hydro-electric power and an additional amount of intermittent or seasonal power up to a further 65,000 kilowatts. The memorandum draws attention to the necessity of combining the hydro-electric plants which would contain about 200,000 kw. of generating capacity, with some 150,000 kw. of thermal generating capacity in large modern units. After allowing for losses the system would be capable of meeting a maximum demand approaching 300,000 kw. making available about 1,420 million kw-hrs. annually of which 800 million will be from hydro-electric installation. The average cost of a unit is expected to be one fourth of an anna.

It is estimated that the capital expenditure involved in the project would be about Rs. 55 crores. Financially, the project would be self-liquidating and is a successful economic proposition. It will vitally affect and reorientate the lives of about 5 million persons living in the Valley and about 2 million persons living in urban areas.

FAMINE ENQUIRY COMMISSION'S REPORT—II

THAT the State should recognize its ultimate obligation to ensure food supply sufficient to maintain health not for some people in extreme emergencies but for all the people for all time to come is the main principle affirmed by the Famine Enquiry Commission in the second part of their report just published. During the past 100 years, the Government of India have accepted the responsibility of preventing widespread deaths from famine, but they have so far refused to accept further obligation of taking every possible step not only to prevent starvation but to improve nutrition and create and maintain a healthy and vigorous population.

The report surveys the food problem, *e.g.*, the causes and remedy of scarcity of food stuffs prevailing in all parts of India except Bengal, on which a separate report was published earlier (See SCIENCE AND CULTURE, X, p. 511), and suggests the lines of a food policy designed to avoid famines in future and to improve the diet of the people for a better standard of health. It deals with the Indian food problem in relation to the agricultural and economic conditions in the country and makes recommendations for raising the standard of living of the vast majority of India's growing population. It estimates that population might increase by 100 millions in the next 25 years and discusses its bearing on food supply.

The commissioners believe that enough food can be produced in India to maintain a larger population on an improved diet. The cardinal aim must be to attain self-sufficiency in cereals whose prices must not be allowed to fall below an agreed minimum. They consider it more practical to concentrate on increasing crops than on controlling population and they hold that, as in other countries, a fall in India's birth-rate is likely to follow and not precede economic betterment which must take place primarily through rehabilitation of agriculture.

Increased attention to irrigation, fertilizers, protection against pests, improved varieties of seed, research, livestock improvement and diversification of crops is recommended. Improved implements, more general mechanization and particularly the use of small tractors are proposed. They have considered the problem of agricultural holdings, fragmentation and the different forms of tenure. The commission as a whole recommend another enquiry into the permanent settlement.

Reliable information on such vitally important matters as the acreage and progress of crops could not be compiled owing to lack of staff. With regard to nutrition, the commission recommend an increase of 200 to 250 per cent of fats and oils. On the question of milk, the commission consider that there is no immediate prospect of an increase in production to such an extent that it can be a regular article of diet consumed in adequate quantities by the poorer classes in the greater part of India. The commission discuss the place of potatoes, sweet potatoes, tapioca and plantains in the agricultural economy of the country.

In a minute of dissent, Mr Afzal Hussain says that overemphasis on cereals is misplaced. It gives an exaggerated and unnecessary importance to this source of food, and such a policy will be a serious obstacle in the path of satisfactory solution of the food problem of India so far as concerns the health and physical efficiency of the people. India cannot continue in the traditional rut, basing her food economy on cereals. Other countries have shifted over to tubers, and there is no reason, he believes, why India should not do the same.

Sir Manilal B. Nanavati, in his dissentient note, says that resolute action is needed to reform India's agrarian economy. The objectives of such action should include the following: All lands should be owned by Government, *i.e.*, the intermediate feudal interests should be removed; occupancy rights should be given to cultivators with certain reservations such as restrictions as to sub-division of the plot, transfer of land etc.; these holdings should be economic units and should be as far as possible in one block; the land should be cultivated by the man who owns it and the holdings should be taxed on a graduated scale. He further urges the necessity for an early abolition of the permanent settlement.

The commission finally hopes that this would be the last of famine commissions and the first of a series of food commission in India.

EXPANSION OF RAILROADS IN AUSTRALIA

We understand that plans are being made to rebuild the whole of Australia's networks of railroads. Seven great railway systems are concerned in a scheme to link six different gauges in one chain, while still operating under separate governmental managements.

The work has been blue-printed in two phases. The first and most important one involves conversion of 8,470 miles of existing track, and construction of 1,600 miles of new lines, at a cost of about Rs. 76 crores. It includes building of 578 locomotives and 26,000 items of rolling stock, supply of 850,000 tons of steel for rails and fastenings, and metal sleepers, 12,000,000 timber sleepers, and 26,000,000 super feet of sawn timber. This work will occupy the equivalent of 103,000 man-years.

The unification of the secondary rail networks with the main trunk routes is planned under the second phase of the scheme, which has not yet been worked out in great detail.

The total amount to be spent on standardization and modernization has been roughly estimated at Rs. 224 crores, which is nearly equal to one-tenth of Australia's expenditure on war. The work will be spread over eleven years, unless it is decided to quicken the programme.

COAL CONSUMERS ASSOCIATION

We are glad to learn that a Coal Consumers Association has been formed at a recent meeting of the representatives of the industrial consumers of coal, both to safeguard the interests of consumers and to instil in the public a higher appreciation of the necessity of coal conservation and fuel economy.

During the nine years that have passed since the appointment, by the Government of India, of the Coal Mining Committee in 1936, the coal situation in India has steadily deteriorated through exhaustion of certain mines yielding coking and other coals, and the misuse of metallurgical coking coal for industrial and locomotive steam raising purposes, for export and bunkering etc. The growing scarcity of good and second class coal, to certain extent necessitated by shortage of wagons, has now culminated in a serious coal famine leading to the closing down of several factories. The present controlled prices of Bengal and Jharia coal vary from Rs. 12 to Rs. 15 per ton at the pit. It is apprehended that prices may go up to Rs. 28 to Rs. 30 on the removal of control after the war, owing to increased demand for coal for industrial purposes. The present annual production of about 22 million tons falls far short of India's estimated post-war requirement of about 35 million tons of coal per year, and there is little prospect of increasing this production beyond 22 million tons, as past experience amply shows.

A strict and judicious policy of conservation appears to be the only solution of the serious coal famine that has already been set afoot. The newly created Association, we trust, can do much to minimize the effects of the crisis in the coal situation and protect the interest of the consumers by representing to Government and the public the consumers' point of view with regard to questions affecting coal, such as prices, production, railway freights, wagon facilities etc.

Mr D. C. Driver of the Tata Iron & Steel Co. Ltd. has been elected President and Mr H. Thorton of Messrs. Indian Iron & Steel Co. Ltd., Vice-President of the Association. The office is situated at Security House (2nd Floor), 102-A, Clive Street, Calcutta.

INDIAN CENTRAL COCONUT COMMITTEE

Inaugurating the fifth all-India commodity committee in Trivandrum on 20th April last, Mr H. R. Stewart, Vice-chairman, Imperial Council of Agricultural Research, stressed the importance of the coconut industry to the southern part of the west coast of India that had not received the stimulus of research and specialized and expert attention so far. He said, "To-day there is an acute shortage of copra and coconut oil, and India which used to be one of the chief sources of supply for world markets has now not only ceased to export either copra or oil but, owing to the increased industrialization of the country, has to import considerable quantities of these products from outside sources. The need is urgent and the time opportune to initiate concerted measures for intensification of production, for better utilization of coconut and coconut products and for rehabilitation of the industry, which in the past appears not to have had full scope for development owing to competition from imported products." It is for the *Indian Central Coconut Committee* to initiate and carry through measures essential for attaining these ends.

Sir C. P. Ramaswamy Aiyar, Dewan of Travancore, announced at the meeting that, if in excess of the income from the cess, any funds were required for research work, the Government of His Highness the Maharaja of Travancore would be prepared to bear 50 per cent of such additional expenditure. This is indeed encouraging. It is understood that Alwaye has been selected as the headquarters of the committee.

INDIAN CENTRAL OILSEEDS COMMITTEE

A bill providing for the creation of a fund to finance research in oilseeds by means of a cess at a rate not exceeding one anna a maund was referred to

a select committee by the Central Assembly in April last.

Introducing the bill, Mr J. D. Tyson pointed out that levy of the cess at the maximum rate would fetch a revenue of about rupees 24 lakhs. India produced one-fourth of the world's oilseeds before the war. Much more use could have been made of our immense resources in oil seeds by the introduction of new methods, new industries and by an improvement of those already established. A co-ordinated programme of research would prove helpful to the grower, manufacturer and the consumer.

The fund would be administered by a committee which would include the Vice-chairman, I. C. A. R., five representatives of the Central Government, seven representatives of the provincial government, one representative of the interested State Governments, fifteen representatives of growers, seven representatives of the industry, eight of trade and commerce, three of consumers and five, representing miscellaneous interests.

We welcome the decision to constitute the oilseeds committee, but we have to point out that the committee as proposed to be constituted has no representatives of Universities and other non-official scientific bodies, where research work is being conducted on the various aspects of oilseeds.

ROAD BOARD FOR INDIA

PRESIDING at the annual meeting of the Indian Roads and Transport Development Association at Bombay, Mr T. R. S. Kynnersley stressed the vital role that road construction must play in both the immediate and long-term aspects of post-war reconstruction, the desirability of having an independent Road Board with adequate powers and the authority and the need for strengthening the Central Road Executive with sufficient funds and staff. Without adequate development of roads, vast spaces of India are practically dead and adequate rural development can never be achieved.

The construction of new roads will so much assist in reducing transport costs, in increasing agricultural output and in changing over cultivation to money crops, including fruits and vegetables, that for every Rs. 100/- spent annually on road construction and maintenance the community will benefit by an increased annual income of Rs. 277/-.

India, with an approximately 1,580,000 sq. miles, has only about 74,000 of metalled roads and about 226,000 miles of unmetalled tracks, by courtesy designated roads. The proportion of road mileage here works to about 35 miles per 100 sq. miles as against 200 in the U. K. and about 100 in U. S. A. In U. K. and U. S. A., all the roads are metalled, whereas in India the greater portion of the roads in the interior are mud tracks almost impassable to wheeled traffic during monsoon periods.

It is estimated that to build new metalled roads 18 ft. wide would cost about Rs. 10,000 per mile, and at least 3 0,000 miles of new metalled roads are necessary at a total cost of Rs. 303 crores for the proper development of the country. In addition, 226,000 miles of unmetalled roads would involve a total cost of Rs. 113 crores.

TRAINING IN BOTANY, ZOOLOGY AND IN ANTHROPOLOGY

THE Government of India have decided to institute with effect from the current year a course of preliminary basic training in Systematic Botany and Taxonomy at the herbarium of the Royal Botanic Garden, Sibpur and in the Systematics of Zoology and in Anthropology at the Zoological Survey of India. Six such post-graduate research students will be selected in Botany (3 for training in higher plants, one in mosses and ferns, one in algae and one in economic botany), four in Zoology and two in Anthropology every year. Recruitment will be effected in consultation with the various Indian Universities, and the students selected will be paid a stipend of Rs. 150 per mensem each during the course of training, which will be spread over for a period of two years.

No guarantee of employment on the completion of their training is given, but an attempt will be made to provide them with suitable employment in the Botanical Survey, the Zoological Survey and perhaps in the proposed Anthropological Survey of India. Such students as show a marked proficiency in research during the course of their training may be selected by the Government for higher training abroad.

We have discussed at length the subject of reorganization and expansion of the Botanical Survey and possibilities in the exploration of the flora of India in a leading article of our September issue. We are not aware as yet of the Government of India's future policy with regard to this important Survey.

It has been recently estimated by a former Government official that, as a result of 97 years' work carried out by officers of the Geological Survey of India, an average of 500 sq. miles can be accurately surveyed each year, and that the average service in the field is about 10 years per geologist. Roughly 100 geologists in all have been so far employed since 1846 so that theoretically only 500,000 sq. miles could have been examined in any detail during the time, and there remains over a million sq. miles to scrutinize.

On the basis of this calculation, the position of the Botanical Survey is still worse and hence the Government of India's proposal to train 6 botanists per year in Systematic Botany and then, without any obligation, to provide them with employment and facilities for the survey of India's flora is a lukewarm support in their plans for post-war reconstruction of this survey and more so when it has been found possible to strengthen the Geological Survey with about 22 additional Geologists immediately. The Government of India have drawn up a scheme to expand the Geological Survey of India to help exploration of the country's mineral and water resources and assist post-war economic development. The preparation of a geological map which will provide the basis for all other geological work is envisaged in the scheme. Importance is given to mineral development and economic geology.

As a first step, the existing mapping circles will be increased and two new circles for mineral development and engineering geology will be added with expert staff both Indian and foreign.

The advice of the Survey will be made available to provincial Governments, Indian States, commercial bodies and the public.

We are also not aware as to who are going to train these trainees and the nature of the training proposed to be given. But we know that the Botanical Survey has to its credit only 2 officers helped by 2 officers of the Bengal Government, all of whom are fully occupied with routine work. The basic training in Systematic Botany and Zoology are given in several Indian Universities and hence we are of the opinion that the Government of India should revise their decision and recruit at least a dozen experienced and able botanists who are experts in the different groups of plant life and seriously commence the work of exploration of the Indian flora without any further delay.

NATIONAL PLANNING COMMITTEE

A MEETING of the National Planning Committee was held at Bombay recently, Pandit Jawaharlal Nehru presiding. It was agreed that the Committee's work must be continued and that there was a need for a central organization of this kind to keep alive in the country the idea of the necessity of bringing about planned economy. It was further decided to review the question of planned economy in the light of the changes due to war conditions. The past five years have worked great change in people's minds and forced them to think in terms of large scale planning.

Fresh directions would be given to the sub-committees for revising their reports. The various plans for national planning placed before the country would be reviewed with a view to speeding up production and organizing distribution in such a way as to bring about the maximum increase in the standard of living of the people within a minimum period of time.

Much of the requisite data for planning is not in existence and such as exists is not made available to the public. Government reports have not been published for a number of years and the materials collected by the various panels appointed by the Government are wholly inaccessible. The release of statistics and other information for the use of the National Planning Committee was further demanded by Pandit Nehru. And he urged that there must be a people's National Government in order to plan.

It may be recalled that the National Planning Committee was appointed by the President of the Indian National Congress in October 1938, with Pandit Jawaharlal Nehru as chairman, and it appointed 29 sub-committees, held a number of discussions and framed resolutions for the economic and social regeneration of India. Its activities were terminated in 1941 owing to the incarceration of the chairman.

The committee will hold its next meeting on November 6 in Bombay.

NEW PRINCIPAL OF THE GOVERNMENT SCHOOL OF ART, CALCUTTA

Mr Atul Bose has recently been appointed Principal, Government School of Art, Calcutta. It was the late Sir Ashutosh Mookherji who first recognized his artistic talents and the Calcutta University awarded him 'Guruprasanna Ghosh Scholarship' in 1923, that enabled him to study at the School of Painting, Royal Academy of Arts, London.

After his return, he served for sometime as the teacher in charge of the Fine Arts section, Government School of Art, Calcutta. In 1930, he was commissioned by the Government of India to paint the Royal Portraits for the Viceroys House after the originals at Buckingham Palace and Windsor Castle.

It was through his efforts that Calcutta saw in 1933, the inauguration of the Academy of Fine Arts. The Calcutta University recently published a treatise written by him entitled "Verified perspective".

LATE DR STANLEY W. KEMP

WE regret to record the death of Dr Stanley W. Kemp, Sc.D., F.R.S. F.R.A.S.B., Director of the Plymouth laboratory and Secretary, Marine Biological Association, U. K. He served the Zoological Survey of India from 1910 to 1924 as its Superintendent and rendered distinguished services in stimulat-

ing research in marine biology in India, Great Britain and elsewhere.

Dr Kemp specialized in the study of Crustacea and wrote his well known 'Notes on Decapoda in the Indian Museum', a valuable series of publication. He led several expeditions to study the fauna in different parts of India, including the Abor expedition in 1911-12, and in 1922, carried out the explorations of Siju Caves in the Garo Hills.

In 1918, he compiled for the Asiatic Society of Bengal the important "Catalogue of Scientific Periodicals in Calcutta Libraries", which is still the only reference book on scientific periodicals available in Calcutta. Dr Kemp was very keen on establishing a marine biological station in the Andaman Islands. So great was his interest that in 1920 he visited the principal marine biological centres of Europe to gather first hand knowledge of their organization and working, obtained the allocation of a site, and also completed plans and estimates for such a station, which were also approved by the Board of Scientific Advice to the Government of India. But the scheme was ultimately shelved and did not materialize for reasons of financial stringency..

Kemp was appointed director of research to the Discovery Committee in 1924, which organized an oceanographical survey of Antarctic waters and was responsible for the establishment of the Marine Biological Station at South Georgia, mainly for direct observation on whales. He sailed in the *Discovery I* (1925-27) and *Discovery II* (1929-31). The Discovery Reports, the first volume of which appeared in 1929, bear testimony to the high standard of his work.

He was for sometime an honorary secretary, Linnean Society, London, and in 1939, received the Victoria Medal of the Royal Geographical Society. During the war, his advisory activities in the Colonial Fisheries Advisory Committee and the English and Scottish Fisheries departments were of great value. He also sponsored investigations on seaweeds which arose from the war-time need for alginic acid.

ALLIANCE BETWEEN INDIAN INSTITUTE OF SCIENCE AND THE IMPERIAL COLLEGE OF SCIENCE, LONDON

In a letter addressed to the editor of *The Times*, Mr R. V. Southwell, Rector of the Imperial College of Science & Technology, refers to an alliance just concluded between his college and the Indian Institute of Science, Bangalore. The proposal was first made to its Director, Sir Jnan Chandra Ghosh, during his visit to the U. K. in autumn last as a Member of the Indian Scientific Delegation. Its formal acceptance had to wait his return to India. There has been no attempt to define the terms of this *concordia amicabilis*, and this freedom from terms is expected to lead to greater real benefits. It is reasonable to expect, as Mr Southwell writes, that scientific liaison within the empire will be closer in future than in the past, and to the staff and the students who may be able to "exchange" between South Kensington and Bangalore, it will mean much to find awaiting them the normal privileges of the common room and to be welcomed not as visitors but as colleagues.

Cordial relationship already exists between these two institutions, and there are records of scientists having served both the institutions. For instance, the late Sir Martin Forster who was appointed Director of the Institute in 1922 had served the Royal College of Science from 1895 to 1913. The new alliance, it is hoped, will lead to closer and more numerous ties between these institutes in the years to come.

ENHANCED MEMBERSHIP AND SUBSCRIPTION FEES

We owe our readers a word of explanation regarding the decision of the Council in favour of increasing the membership and subscription fees with effect from September 15, 1945. Consideration of the widest possible dissemination of scientific knowledge and information during the serious war-time blackout of foreign scientific news weighed so heavily on us that we strictly refrained so far from increasing the membership and subscription fees despite repeated suggestions. Meanwhile the cost of paper, block-making, printing, etc. has gone on increasing, and there is no immediate prospect of prices coming down to pre-war level. We have made every effort to maintain the get-up of the journal notwithstanding serious war-time limitations and are now determined to further improve it through use of better quality paper gradually released in greater quantities for civilian consumption. This means, of course, increased expenditure. Indian Science News Association, as our readers are aware, is a non-profit organization and depends, for its finances, largely on private benefactions to supplement the inadequate proceeds from the sale of the journal. Under these circumstances the Council have, with great reluctance, decided to increase the membership and subscription fees as follows: —

	Rs. A.
Ordinary Membership Fee	.. 12 0
Life Membership Fee	.. 125 0
Annual Subscription (Inland) ..	.. 7 8
Do. (Foreign) ..	Sh. 15
Single Copy (Inland)	.. 0 10
Do. (Foreign)	Sh. 1·25

While informing our members, subscribers and readers of these enhanced rates, we are confident of their full and unfailing support and co-operation.

SCIENCE IN INDUSTRY

PRODUCTION OF ALCOHOLIC DRINKS IN INDIA

THE sub-committee on Alcoholic Beverages of the Technical Panel of the Food Department recently submitted its report on the production of alcoholic drinks in India. The data collected in the report show that Indian rum does not contain greater quantities of higher alcohols and aldehydes than rum of foreign manufacture. This is important in view of the belief sometimes held that the Indian product contains more fusel oil etc. The report recommends the use of sugarcane juice, *gur*, or molasses for the production of good quality rum, suggests maturation of Indian rum for at least two years, and discourages the use of the spirit from *mahua* and the practice of mixing dilute rectified spirit in its manufacture.

Grapes have been recommended for the manufacture of brandy, and barley or other cereals for whisky. The sub-committee is opposed to the use of diluted rectified spirit flavoured with essence of brandy.

Standardization and improvement of the methods of manufacture of other indigenous liquors are insisted upon, and the manufacturers are advised to apply to Provincial Governments for information regarding the specifications of country spirits.

CHEMICAL COMPOSITION AND SPINNING QUALITY OF JUTE FIBRES

THE relationship existing between the spinning quality and chemical composition of jute fibres are described in the *Technological Research Memoir No. 6* of the Indian Central Jute Committee, published recently. It is observed that spinning quality in general decreases with increasing nitrogen, fat and wax content. Useful data in this connection are tabulated in the pamphlet.

In assessing fibre quality, these chemical analytical data may be used in conjunction with physical measurements. By examining small samples spinning quality of fibres can be assessed which is very useful in connection with breeding trials, agricultural experiments generally and in devising scientific methods of grading.

UTILIZATION OF WATER-HYACINTH

THE Industries Department of the Bengal Government is now interested in the commercial utilization of water-hyacinth and establishment of several centres for handmade paper industry in Bengal. A water-hyacinth utilization factory under the technical supervision of the engineering section was engaged in producing various articles out of water-hyacinth. A special type of chest to conserve ice was designed and manufactured by this factory. To encourage people to take up manufacture of handmade paper as a cottage industry, demonstration parties were organized and factories were started in different parts of the province. Another possibility was the manufacture of plastics. A process has been perfected for producing moulded products of various types. The process which is protected by a patent is said to be simple and inexpensive and to incorporate some novel and unique features. A private limited liability company has been formed for exploiting the process.

Since then, at the invitation of the Bengal Government, Mr Stanley A. Clarke, Head of the Forest Products Section, Council of Scientific and Industrial Research, Australia, has come to Bengal, to advise on the commercial possibilities of the process invented by the Industries Department for converting water-hyacinth into plastic material and timber substitutes with a view to organizing the production on a large scale under State supervision.

It appears that the Bengal Government having failed in their sporadic and unplanned attempts to eradicate this pest, are now encouraging various aspects of commercial utilization of the plant with the possibility of obtaining a monetary return that would perhaps serve as an inducement for its collection and removal. But we feel that such attempts to utilize the pest commercially will never help in its eradication.

It is estimated that the weed covered an area of 4,000 sq. miles in 1930 and it now covers some 10,000 sq. miles, (one-third of which include cultivated land) causing a tremendous amount of damage to economic crops and fish resources estimated at Rs. 5,00,00,000 a year and is thus a menace to Bengal's agriculture and waterways.

The problem of eradication of the pest should now draw the attention of the Central Waterways, Irrigation and Navigation Commission of the Government of India and adequate mechanical appliances evolved for the purpose.

COMPREGNATED WOOD

THAT compregnated wood of good strength and possessing other favourable properties, comparing favourably with foreign samples can be produced from inferior Indian timbers *e.g., Semul, toon* etc. is shown

in the *Indian Forest leaflet No. 77 (1945)*, recently published by the Forest Research Institute, Dehradun. This is the third of the series of leaflets on studies on improved woods. Parts I and II of the series dealt with experiments on improving the properties of wood by impregnation with resins and by lamination. The present part describes further work on improved wood produced by lamination and compression, that is compregnated wood.

After describing the preparation of compregnated wood, the results of tests on their strength, thermal and other properties are recorded. The uses of compregnated wood are varied and many and their applications to industry are also indicated and illustrated in this leaflet. Material prepared at Dehradun has been tested with encouraging results for aircraft propellers, bearings for river barges, tube well buckets, shuttles for cotton mills and fish plates for electrified sections of main line railways.

MANUFACTURE OF SINTERED GLASS FILTERS IN INDIA*

Bh. V. JANAKIRAMA RAO,

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, DELHI

THE sintered or porous glass filter is an indispensible piece of apparatus in chemical laboratories used in several operations such as filtration, preparative work, qualitative and quantitative analysis, gas distribution, extraction etc. The porous glass filter, when made to bigger sizes finds application in the industrial field for the large-scale filtration of chemical acids and alkalies etc. where the usual paper, cloth and wireguaze filters cannot be used. The most important application of fritted glass at the present moment is in the all glass bacteriological filter for obtaining sterile blood serum for transfusion purposes. Apart from the large war-time demand for the bacteriological filter, the peace-time demand of this country for porous glass filters for use in the laboratories is large enough to support an independent industry.

Sintered Glass Filter

The sintered glass filter is an article of German origin. Max Grossmann was the first to study the possibility of making porous glass diaphragms about the year 1923. At about the same time Prof. Huettig of the Jena University was studying the possibility of replacing the Gooch porcelain crucible with asbestos stuff, by some new type of crucible which would obviate the trouble of preliminary preparation before use. It was, however, Dr Paul Hubert Prausnitz of Jena, who gave practical shape to the ideas of Max Grossmann and Prof. Huettig. Till the outbreak of the present war, no other country was manufacturing these filters except Germany. Soon after war broke out, other countries like America and England promptly realizing the scientific importance of these filters, set about mastering the technique of the manufacture of sintered glass filters. One firm in America succeeded in manufacturing these in Pyrex glass. Then followed Great Britain with her "Hysil" porous glass filters.

In view of the difficulties in obtaining these filters from abroad and to meet the ever-increasing demand for them, work was undertaken in the Laboratories of the Director of Scientific and Industrial Research to produce similar glass filters. A stage has now been reached when filters of the whole range of porosities required for chemical and bacteriological work can be produced on a pilot plant scale. Work has been carried out specially with a view to manufacture these filters on a large scale, with Indian raw material and Indian made machinery. The resistance glasses manufactured by some of the Indian glass manufacturing firms have proved quite satisfactory for the manufacture of these filters. Since the raw material, machinery and skilled labour are all available in this country, this industry can have a permanent footing.

The following grades of porosities have hitherto been made in these laboratories.

	Porosity	Average pore size	Colourless glass	Blue glass	Green glass	Red glass
		·001 mm.				
Rough filters.	No. 000	1000	,,	,,	,,	,,
	,, 00	500	,,	,,	,,	,,
Medium filters.	,, 0	250	,,	,,	,,	,,
	,, 1	100	,,	,,	,,	,,
	,, 2	50	,,	,,	,,	,,
Fine filters.	,, 3	25	,,	,,	,,	,,
	,, 4	5 to 15	,,	,,	,,	,,
	,, 5 or 3	0·5 to 1·5	,,	,,	,,	,,

* Paper read before the 32nd Session of the Indian Science Congress at Nagpur on the 6th January, 1945.

The uses to which these filters can be put, are so varied and extensive that an exhaustive account cannot be given in an article like this. Some of their important uses are, however, mentioned here.

Porosity No. 000, i.e., 1000.—From this grade mainly porous glass beads have been made. These beads have been found to be specially useful as an efficient substitute for the porous porcelain bits generally used for avoiding bumping in boiling liquids or solutions. These beads have this advantage over the latter that, while the porcelain bits become useless when once used, due to clogging of pores by the solute, they can be used over and over again and can be cleaned easily as they contain pores of 1 mm. diameter approximately. These beads can also be used for packing columns for gas distribution and also for filling up fractionating columns.

Discs made of this porosity can be used for supporting granular solids which should react with liquids or gases, especially with the latter where the least possible resistance should be offered to the flow of the gas.

Rods and hollow cylinders made of this porosity are very useful for lecture demonstration in colleges, of the property of creeping-up of solutions (*e.g.*, Copper sulphate) during crystallization.

Articles made of this porosity have the advantage of being specially strong owing to the much greater adhesion between its constituent particles which can be allowed to take place at the expense of the 'pore volume' which is not so very important for this grade as in the case of finer porosities where the pore volume is of primary consideration for attaining filtering efficiency.

Porosity No. 00.—Articles made of this porosity have the advantage of having a ratio of greater pore volume to the constituting material, than those of the No. 000 porosity, though not mechanically so strong as the latter. Discs of this porosity can be used for the same purposes as those of No. 000, sometimes with better advantage as in the case of supporting solids of smaller granules. Mantles of this porosity are conveniently used for steam-treatment of materials in suspension.

Porosity No. 0.—Discs made of this porosity are suitable for distribution of gases in liquids, when only low pressures are available. Cylindrical mantles of this porosity can be used for the efficient mixing of two flowing gases, *e.g.*, air and coal gas mixing for blast burners. The pressure necessary to force air through a disc wet with water is from 10 to 15 mm. of mercury. Porous bulbs, mantles, tubes and the like of this porosity have been found to be specially useful in the laboratory for the oxidation of oils and in their treatment with corrosive gases like sulphur dioxide, chlorine etc.

Porosity No. 1.—Sintered glass discs of this porosity are very widely used for gas distribution in liquids. These are also used for filtration of very coarse precipitates and of coarse crystalline substances in preparative work. These discs can also be used as supports for absorptive layers for filtering gelatinous precipitates. Another important application of these filters is, the extraction of coarse grain material in the Soxhlet apparatus.

Thimbles made of the porosity can conveniently replace the usual paper thimbles in the Soxhlet's apparatus as they possess the advantage of cleanliness and of being used over and over again. Another advantage of the porous glass thimble over the paper thimble is its chemical resistance and also the convenience which it affords to weigh its contents before and after the experiment. This subject is dealt with more fully later in the article. The pressure required to force air through a disc of this porosity wet with water is about 30 mm. of mercury.

Porosity No. 2. Filters of this porosity are chiefly used in preparative work with many crystalline precipitates. Discs of this grade can also be used for finer gas distribution in liquids. But it requires a higher pressure to get a stream of bubbles through the disc, *i.e.*, about 40 to 45 mm. of mercury. This being an intermediate grade between grade No. 1, used for coarse precipitates and grade No. 3, used for fine precipitates, will be found to be of great advantage where fairly fine precipitates have to be filtered rapidly, and where sufficient vacuum is not available to use No. 3 filter.

Porosity No. 3.—Of all grades of the glass filter this grade is by far the most popular and the most widely applied to various uses. It finds its application largely in preparative work, with many fine precipitates and in analytical work with medium precipitates. In fact that grade is used for filtering almost all precipitates, coarse, medium and fine alike, except the finest precipitates $BaSO_4$ and Cu_2O for which, grade No. 4 is ideally suited. It is also suited for filtering mercury. Thimbles or discs of this porosity are used in the Soxhlet extractors for the extraction of fine grain material. The use of filters of this porosity for the purpose of gas distribution in liquids is less favoured on account of the comparatively higher pressure required to produce a stream of bubbles through the filter (*i.e.*, about 80 to 100 mm. of mercury). Nevertheless, this porosity is actually preferred in certain cases where very fine distribution and efficient gas washing is the primary factor. A special application of filters of this porosity is the filtration of the viscous cellulose spinning solutions in the manufacture of artificial silk.

Porosity No. 4.—Filters of this porosity are mainly used for analytical work with the finest preci-

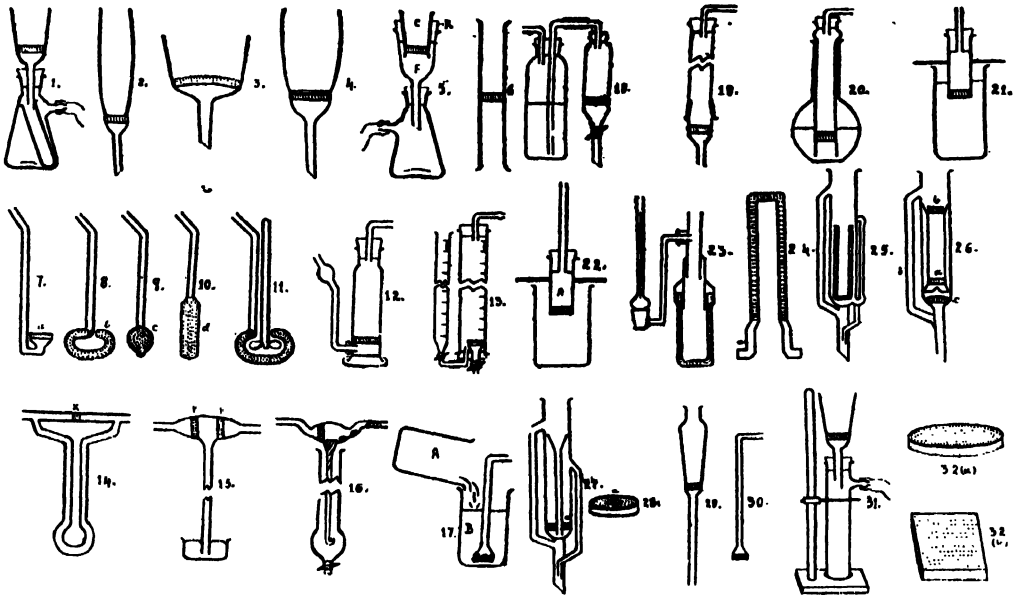
pitates like $BaSO_4$ and Cu_2O and also for preparative work with all fine precipitates. These filters are fine enough to arrest mercury from passing through them at a difference of pressure of one atmosphere on either side of the disc, while allowing enough of free passage for any gas to pass through their pores. On account of this characteristic property of this porosity, these discs are used in making safety valves for mercury in vacuum systems. Micro-filters of this porosity are a speciality. Discs of micro-size *i.e.*, 5 to 10 mm. are also employed in forming salf bridges in electrolytic conductivity experiments. A special use of discs of this porosity is that they can be used as the bed or support for ultra-filters such as collodion film or animal membrane. The ultra-filter film is conveniently formed on the disc which gives it the necessary mechanical strength to withstand the vacuum to be applied.

these filters are put, in conjunction with various kinds of glass apparatus.

Funnels

Sintered glass funnels are the most widely used form of the porous glass filter. These are made to all sizes from 5 mm. diameter or even more—porosities 2, 3, 4 and 5 being more popular than the rougher grades.

Funnels of porosities 3 and 4 and of disc diameter 25 mm. to 40 mm. are popularly used in qualitative analysis. Fig. 1 shows this type of filter in actual use. The test tube inside the flask, is changed to collect the different filtrates for individual examination.



Sketches of Filters.

Porosity No. 5.—This is the bacteriological filter mostly used now-a-days for blood-filtration *i.e.*, for the preparation of sterile serum out of blood. The extremely small diameter of the individual pores of this filter, *i.e.*, from 0·5 to 1·5 (which diameter is much smaller than that of most harmful bacteria) makes possible, its characteristic property of sterilization by filtration. These filters can very conveniently be used for quick preparation of sterile water for hospitals and dispensaries.

Filters of the above mentioned porosities can take any shape in accordance with the need which they are intended to satisfy. The following is a brief account of some of the various uses to which

The same funnels are also used for various organic preparations as well as for analytical work. Selection of the porosity, depends upon the nature of the precipitate to be filtered. Precipitates in these funnels can be safely dried in a hot air oven upto a temperature of 150°C, without the necessity of removing the precipitate from the funnel.

Fig. 2 is a mercury filtration funnel of porosity No. 3. It has a long container above the filter bed to hold enough of mercury to enable to pass down through the pores by its own weight. If suction is applied from the bottom, the extra length of the funnel above the disc becomes superfluous. Funnels of the popular shape as shown in Fig. 3 of porosity

No. 3 may also be used for filtering mercury if suction is applied. But the advantage in this special funnel for mercury is that the filter bed is much stronger and can better withstand the combined stress exerted by the atmosphere and the weight of mercury column above the filter bed. Filtration of mercury with this filter is a very quick and clean method of freeing mercury from impurities by mechanical means.

Fig. 3 represents the usual buchner funnel made of glass. These are generally made upto a maximum of 6″ diameter. Bigger diameters cannot withstand sudden thermal shocks of the usual laboratory conditions of working. It is also extremely difficult to manufacture buchner funnels which contain discs of more than 6″ diameter fused into them, since the larger the diameter the more difficult is the process of annealing. Concavo-convex filter discs are fused into the containers, instead of plane discs in order to increase the mechanical strength. The thickness of the disc is so calculated as to withstand a difference of pressure of one atmosphere on either side of the porous disc. These funnels are usually made in porosity Nos. 2, 3 and 4.

Fig. 4 is that of the bacteriological filter. The filter disc consists of two layers, the bottom one of a rougher grade No. 3 to serve as a support and the top layer of the finest grade *i.e.*, No. 5, which is the true bacteriological filter. The bottom rough grade layer is necessary as a support since the layer of No. 5 at the top cannot withstand by itself, a pressure difference of one atmosphere which is required to suck the liquid down through its fine pores. Making a thick disc of No. 5 porosity alone is disadvantageous, since in that case the resistance offered by the capillary pores is too great to allow free filtration to go on. All glass bacteriological filters are made upto 60 mm. maximum diameter.

Coloured Filters

Coloured filter discs have a definite advantage over the colourless ones, in that they offer a better background for white precipitates and give better convenience for the complete removal of the precipitate from the filter. Sintered glass discs of all porosities can be made in deep or light shades, as may be desired, of any colour such as black, blue, green, red, yellow, amber etc. and fused into colourless or white glass containers in the usual way. These filters while possessing working efficiency have an appeal to aesthetic sense. A novel improvement in detail in the construction of these filter-discs is the incorporation of a coloured layer on a white layer with a sharp line of contact between the two. These filters have been found to be specially convenient for filtering and thoroughly washing white precipitates suspended in coloured solutions. While the top coloured layer serves as a good background for the white precipitate the bottom white layer serves to indicate the last traces of the coloured solution dripping down the filter.

Sintered Septum Gooch Crucibles

The sintered septum glass crucible is an ideal piece of apparatus for quantitative work. It is usually made in diameters of 20 to 30 mm. though 15 mm. and 40 mm. diameters are not uncommon. It is made of all porosities from No. 1 to No. 4. No. 3 is used for coarse and medium precipitates whereas No. 4 is used for very fine precipitates and a majority of analytical purposes. Crucibles of porosity Nos. 1 and 2 are used with asbestos bed just in the same way as a porcelain Gooch crucible, the rough porous glass bed in this case serving merely as a support for the asbestos bed. The filtration is effected as shown in Fig. 5. The crucible C is fifteen in the adapter funnel F, by means of a rubber ring R ; and suction is applied to the flask from below.

Drying of the precipitate is effected by transferring the crucible to a drying oven to be heated to a maximum of 150°C. When necessary, the crucible can be heated even upto 600°C. Provided that in this case a well controlled oven (preferably electrical) is used, wherein the temperature is regulated to reach up to 600°C. gradually in about 1 to 1½ hours. The cooling must also be done in the same oven at least down to 300°C. at the rate of fall of temperature of about 2°C. per minute.

Gas Filters

Fig. 6 is a simple form of gas filter which can be used for filtering dry gases. The speed of filtration alters with the porosity and the diameter of the disc used. Moist gases also alter the speed of filtration due to the capillary constant of the moistening liquid. The two wide open ends of the filter facilitate easy cleaning. Filters of this kind have been successfully used in these laboratories for filtering air in connection with experiments on blood processing.

Gas-washing Apparatus

Figs. 7, 8, 9 and 10 are different forms of gas distributors in liquids. Gas is usually forced through the sintered glass limbs marked *a*, *b*, *c*, *d* so that a

uniform stream of bubbles rises up the column of liquid to give the maximum exposure possible. Fig. 7 represents the usual type of gas distributor with a disc *a* of sintered glass fused to its limb. Fig. 8 is a typical example of the sintered glass tube in use. Fig. 9 contains a porous 'bulb' or 'pear' at the working end while Fig. 10 is a similar one with a porous cylinder in place of the 'pear'. Figs. 8, 9 and 10 are special designs developed in these laboratories and have been found to be particularly useful for certain purposes *e.g.*, Fig. 8 for chlorination of rubber and Figs. 9 and 10 for the oxidation of oils. Fig. 8 is designed to accommodate the waned stirrer, which is to stir the very viscous rubber solution at the centre, while the fine bubbles of chlorine forced out of the peripheral porous glass tube mix efficiently with the viscous liquid in motion, (Fig. 11). Gas bubbles of any fineness can be obtained by a selection of the proper porosity of sintered glass. Fig. 12 is a modification of the usual type of Dreschel's wash-bottle with the insertion of the sintered glass disc near the bottom. Gas distribution is evidently more efficient than in the usual bubbling system. The design is particularly suited for thorough cleaning of the apparatus. It is free from delicate parts and is simple in construction.

Another application of the sintered glass disc for gas distribution is illustrated in Fig. 13 which is part of a simple apparatus and has been used in these laboratories for testing efficiency of air foam solutions.

Fig. 14 represents a modified type of flowmeter in which the usual capillary at X is replaced by a sintered glass disc of the required porosity.

Mercury Safety Valves

A common trouble in routine vacuum distillation work in chemical laboratories is with the frequently used simple type of mercury manometer from which mercury rushes into the system while releasing vacuum and applying suction with less caution. A simple form of mercury safety valve which obviates the trouble is shown in operation in Fig. 15. The porous diaphragm *P* of porosity No. 3 gives the necessary free passage for the fast flowing gases, and prevents any sudden rush of mercury into the system. Fig. 16 represents part of a semi-automatic type of Sprengel's pump, to which a similar type of mercury safety valve is attached to prevent mercury overflowing the apparatus. Suction is applied at *S* by a water jet pump and the spent mercury is sucked up in pellets into the reservoir *R* to be fed into the system once again.

The above mercury valves of porosity No. 3 are suitable only at low pressures, since mercury can pass through these filters if powerful suction is applied. For high-vacuum work, therefore, porosity No. 4 has got to be used. A typical application of this type of mercury safety valve is its use in conjunction with the short type of Mac.,eod's Gauge in which the danger of mercury rushing into the system is great. The arrangement is much the same as in Figs 15 and 16.

Immersion Filters

Where bulk quantities of liquids containing very small amounts of suspended solid matter, are to be filtered the immersion filter finds its important application. Fig. 17 illustrates its use in the laboratory. The bulk liquid containing suspended matter from the reservoir is fed into the beaker B by means of another beaker A, while the filter rapidly drains off the liquid leaving all the solid matter to collect more and more in it. The solid matter is later filtered in a sintered funnel and collected in the usual way. An important industrial application of this filter is the draining of supernatant liquid in settling tanks which contain finely divided sediment at the bottom and sides, as for instance, in the large scale manufacture of pigments like TiO_2 by precipitation methods. This type of glass filter is particularly useful where the supernatant liquid happens to be acidic or alkaline. It can also be used for sucking out mother liquors from crystallization tanks, without disturbing the crystals. Another important industrial application of the filter is in filtering commercial acids from bulk storage tanks.

Pressure Filters

Volatile liquids like ether-sulphuric, petroleum-ether, acetone etc. which contain very fine solid suspensions, do not allow themselves to be filtered in the ordinary way *i.e.*, through a filtering funnel by applying suction from below.

The pressure filter is specially suited for such cases. Here the liquid, instead of being sucked through the filter disc, is forced down by pressure above. Fig. 18 is an illustration of continuous filtration of the liquid from a reservoir. If only a small quantity of liquid is to be filtered at room temperature, the pressure arrangement can be dispensed with. In that case the neck of the filter has to be closed by a cork and the contents shaken. This will produce enough vapour pressure above—the liquid to force it down the filter. In cases where such volatile liquids have to be filtered hot *i.e.*, near about their boiling temperature in order to prevent crystallization of dissolved matter before filtration, the pressure filter can be enclosed in an outer jacket (a bottomless bottle

can serve the purpose quite well) which would contain the heating agent.

Foundation Beds

Sintered glass discs of the rougher grades (*i.e.*, No. 0 to No. 2) find a good application as supports on foundation beds, for coarse grain material. Fig. 19 represents an improved form of apparatus with a sintered glass foundation bed supporting coarse grain alumina. Closely related organic compounds in solution, which are otherwise difficult of separation are isolated easily by taking advantage of the different colourations produced in the alumina due to surface absorption while filtering through the medium.

Fig. 20 represents a low pressure gas generator for experimental purposes. The solid material (zinc, marble etc.) is supported on the sintered glass disc which is of No. 00 or 0 grade porosity and offers very little resistance to the liquid which should react with the solid. The simple construction of the apparatus facilitates thorough cleaning.

A simple arrangement for lecture demonstration purposes, is shown in Fig. 21 to demonstrate the process of solution. A coloured crystal, (a crystal of Potassium dichromate or Copper sulphate) is placed on the coarse sintered septum of the glass vessel A, which is suspended in the jar of water B. The whole process of solution, as the crystal dissolves in water can be closely observed.

Sintered glass filters are best suited for experiments on osmotic pressure. They possess the special advantage of uniform porosity of any desired fineness and of taking any desired shape. An arrangement for demonstration of osmotic pressure is illustrated in Fig. 22. The usual porous pot or the inverted funnel with its diaphragm is replaced here by a special glass crucible A with sintered septum of the finest porosity (Grade No. 5). The advantage of this improved apparatus over the conventional ones is that it facilitates complete visibility for closer observation and study. The simplicity of its construction allows thorough cleaning facilitating its use any number of times. Fig. 23 is the layout of the familiar form of Pfeffer's apparatus for osmotic pressure measurements, with an all glass porous cell. A somewhat smaller type of porous glass cell is separately shown in Fig. 24. This cell is intended for very high osmotic pressure measurement in conjunction with metal seatings. It is therefore made of a glass of high tensile strength. It has a thick rim R of solid glass which continues into the porous glass part P of the cell. The solid glass rim facilitates firm fastening, and ensures freedom from leakage, a property which gives the all-glass porous cell a definite superiority over the usual all-porous clay cell.

Extraction Apparatus

The sintered glass filter has now largely displaced the paper thimble in the Soxhlet extraction apparatus. Porous glass is obviously superior to the porous paper, with regard to tensile strength, resistance to chemicals, cleanliness and the advantage of using it over and over again. The usual form of Soxhlet apparatus is shown in Fig. 25 with the all-glass porous-thimble in place of the paper thimble. Fig. 26 is a suggested modification of the usual Soxhlet apparatus. There are three porous glass discs *a*, *b*, and *c* used in this apparatus. The main filter is the one *a* which is fused into the transparent glass thimble. A smaller and loose disc *b*, laid over the material after filling serves to distribute the current of solvent during extraction. The other disc, *c*, which is of grade 00 serves a double purpose. It offers a check partially to the ascending hot vapour and diverts it into the side tube *s*, while allowing only part of the hot vapour into the Soxhlet, to keep the thimble and its contents hot. At the same time it gives free passage to the solution flowing down from the thimble. This modification, while possessing the advantages of the glass thimble *i.e.* the transparency, and the ease of weighing it with the contents before and after experiment, has the special advantage of hot percolation of the solvent through the material to be extracted. The thimble and the contents are kept almost at the boiling point of the solvent for efficient extraction.

The type of the Soxhlet used for the extraction of liquids is represented by Fig. 27. In this case the sintered glass disc, *a*, as shown in better detail in Fig. 28 has a hole at its centre through which passes the tube *t* carrying the solvent to the bottom. The solvent which is lighter than the liquid to be extracted, is forced up the pores in fine streams ensuring efficient extraction.

Glass Filters for Micro-chemical Work

Glass filters are indispensible for micro-analytical work as no other filter possesses the advantages of the glass filter for this work *viz.*—transparency, thermal and chemical resistance, extreme neatness, and the necessity of drying the precipitate in the filter itself without transference, etc. Fig. 29 represents a micro-filter. The filter disc is of 5 mm. diameter made of No. 3 or No. 4 porosity.

Fig. 30 is a micro-immersion filter. This is of special value, in the quantitative separation of fine precipitates, the bulk of which settle at the bottom

leaving a fine layer of the precipitate at the surface of the liquid as well. The filter sucks out the liquid without any loss of precipitate. It has also been found to be of great use in routine experimental preparative work, such as for instance, in lecture demonstration, where liquids have to be filtered out without transfering the contents into the filter.

A semi-micro-filter with the disc diameter of 10 mm. is shown in fig. 31. This can be used for all types of work, qualitative and quantitative analysis as well as preparative work on semi-micro-scale. These filters are made of Nos. 2, 3, and 4 porosities largely.

Technical Filters

The need for technical filters depends upon the need for large scale industrial filtration. Such a need has only just begun in this country. With the growing industrial demands of this country for the large scale filtration of commercial and spent acids and of alkali solutions in the soda, potash and allied industries, the technical filter of sintered glass is bound to have its due importance. Further its application in the large scale filtration of the viscous spinning solutions in the rayon industry which is yet to start in our country is another field full of promise for its application. Sintered glass slabs and discs of porosities from No. 000 to 4 can be made as big as 1½ feet square and 1½ feet in diameter with a thickness of about 1 inch.

Technical filter slabs (Fig. 32 a and b) cannot, however, be fused into glass containers of such big sizes. They can be packed or sealed along the edges with asbestos or any acid and alkali-resistant cement, into containers of lead or porcelain.

Apart from the usefulness of these filter slabs in large scale filtration, gas distributors of porous glass also find their application in industry and have a bright future. Large tubes and mantles of sintered glass with suitable glass adapters are particularly useful where large scale distribution of poisonous or corrosive gases like chlorine, sulphur dioxide etc., through viscous liquids like thick oils, is necessary and where it is desirable that the gases should be absorbed as completely as possible before they can bubble out of the liquid and foul the atmosphere. Large scale chlorination of rubber, and bleaching of pulp in the paper industry are two more examples in this field.

Conclusion

This industry has every prospect of becoming a permanent one in this country and has a bright future. The problem of machinery offers no serious difficulty since experience has proved that machinery made in India can serve the purpose efficiently enough even on a mass-production scale. The only problem of any serious magnitude at the present moment is that of fuel in view of the present shortage of coal. But it may be noted that the quantity of fuel required for this industry is comparatively very small. The problem can also be overcome by setting up the factory in cities like Calcutta and Bombay where the required quantity of coal gas can be made available from the city supply. The necessary skilled labour can be easily made available. There is, now-a-days, enough technical personnel fairly well-up in the art of glass-blowing in this country. With a little training the experience of some of these men can be easily adapted to this technique. The raw-material required for the special type of glass is mainly high-class sand or quartz ; and these, especially the latter are available in abundance in this country. The very few pure chemicals required are not rare.

It will be seen from above that all the requirements of this industry *viz.*, raw-material, plant and machinery and technical personnel are all available in this country. They are available much cheaper in this country than in America, Great Britain and Germany who are the likely competitors in this line in the post-war period. This industry has therefore every prospect of overcoming the post-war competition.

An estimate of the cost of production in a factory for making 100 glass filter funnels per day is given below. The pre-war prices are also given side by side for comparison.

Cost Sheet

Capital Investment :—

Gas Plant (Installation)	...	Rs. 25,000
Furnace ...	...	Rs. 5,000
Machinery ...	..	Rs. 10,000
Total ...	...	Rs. 40,000

COST OF PRODUCTION

Details of items	Quantity	Pre-war Price		Present Price	
		Rate	Amount	Rate	Amount
Quartz (including transport)	2 cwts.	Rs. 15 per cwt.	Rs. 30-0-0	Rs. 30 per cwt.	Rs. 60-0-0
Chemicals	...	...	,, 15-0-0	...	,, 40-0-0
Coal	4 cwts.	Rs. 8 per ton	,, 2-0-0	Rs. 45 per ton	,, 11-4-0
*Labour	...	...	,, 49-0-0	...	,, 95-0-0
Depreciation at 10%	...	...	,, 10-0-0	...	,, 10-0-0
Power	...	...	,, 4-0-0	...	,, 8-0-0
Repair and maintenance	...	...	,, 5-0-0	...	,, 10-0-0
Miscellaneous	...	...	,, 5-0-0	...	,, 10-0-0
Total cost of 100 filters ...			Rs. 120-0-0		Rs. 244-4-0

	Pre-war	Present
Cost price of one filter	Rs. 1-3-2	Rs. 2-7-0
Market price of one imported filter	,, 4-0-0	,, 10-0-0
Percentage profit	210%	300%

		Pre-war		Present	
*One Production Manager	Rs. 10-0 per day	Rs. 10-0-0	Rs. 20-0 per day	Rs. 20-0-0	
Two Chemists	,, 3-0 per day	,, 6-0-0	,, 5-0 per day	,, 10-0-0	
Ten glass blowers (trained)	,, 2-0 per day	,, 20-0-0	,, 4-0 per day	,, 40-0-0	
Two Laboratory Assistants	,, 1-8 per day	,, 3-0-0	,, 2-8 per day	,, 5-0-0	
Ten trained workmen	,, 1-0 per day	,, 10-0-0	,, 2-0 per day	,, 20-0-0	
Total ...		Rs. 49-0-0		Rs. 95-0-0	

The cost of production as shown above can be appreciably curtailed by using a good quality sand in place of the costly quartz. In spite of the fact that even the best quality sands available in this country require purification by chemical treatment, thereby involving considerable expenditure, they can be preferred to the much more expensive quartz.

It should, however, be noted that although it will be more economical if the manufacture is taken up by the existing glass manufacturers, there is nothing, with regard to the availability of men, material and equipment, which can discourage its having an independent and self-contained existence.*

* The author wishes to express his indebtedness to Sir S. S. Bhatnagar for providing the facilities for this work and to Dr Atmaram for some valuable suggestions.

MEDICINE AND PUBLIC HEALTH

POLYPORIN

FILTRATE of *Polyprus* Sp in Czapek-Dox medium —*p*H 7, at room temperature (29° to 32°C) was tested to be highly bactericidal in action (*Current Science*, *13*, September, 1944, p. 233). Since then, chemically isolating the active principle of this filtrate *e.g.*, polyporin and trials carried out *in vitro*, in plate cultures of typhoid, cholera, dysentery and B. *coli* produced lytic action in about 24 hours and have thus a remarkable bacteriolytic action. A sodium salt of polyporin (extract from the sporophores of the dried fruit-body of *polyporus*) prepared after Berger's method (modified), is found to have greater potency than the crude filtrate.

Experiments so far carried out on animals (guinea pigs) with polyporin have shown it to be completely non-toxic. It is non-haemolytic ; in intramuscular injections it produces no pyrogenic effect in man ; with proper sterile conditions it retains its potency for about a month at room temperature (22°—32°C).

Experiments *in vivo* on typhoid, and cholera patients at the Carmichael Medical College Hospitals, Calcutta are now being carried on (*Nature*, *156*, August 11, 1945).

This new mycologic and chemotherapeutic agent discovered by the eminent mycologist, Prof. S. R. Bose of Calcutta, promises to be an efficacious remedy for bacillary infections—remedy for which with the wonder drug penicillin is not so far established. Its importance for the tropical diseases is emphasized by the fact that it retains its potency even at room temperature.

WORLD STANDARD AND UNIT FOR PENICILLIN

An international conference under the auspices of the League of Nation's Permanent Commission on Biological Standardization was held in October, 1944 (briefly reported earlier in SCIENCE AND CULTURE, *10*, June, 1945), at the Royal Society's premises presided over by Sir Henry Dale, president of the society. The conference was attended by delegates from the United States, France, Canada, Australia, Britain, South Africa and India, Sir Percival Hartley —director of the medical research council's department of biological standards and custodian on behalf of the League of Nations of the international standards established by its permanent standards commission, —acting as its secretary.

The conference recommended that a quantity of pure penicillin sodium salt be adopted as international standard and kept at the National Institute for Medical Research, London. An international unit of calcium salt of penicillin shall also be established.

They further recommended that the international unit should be defined as the specific penicillin activity contained in 0·6 micrograms of the international penicillin standard defined above and 2·7 micrograms of the present international penicillin working standard be accepted as containing 1 international unit of penicillin. This decision makes an important stage in the development of this remarkable medicament. The unit now adopted is approximately equivalent to the unit originally adopted by Heatley and Florey and commonly known as the 'Oxford' unit.

In the inter-war period this commission has established a series of biological standards over thirty in number, including standards for antitoxins, vitamins, arsphenamines, insulin, pituitary extract and sex-hormones. (*Science*, *101*, June 22, 1945).

The Government of India have now decided to manufacture penicillin at the Indian Institute of Science, Bangalore. One hundred million units of penicillin will be produced every month and plant and equipment for production on a vast scale are being installed, says a press note.

A MINIMUM HYGIENIC STANDARD OF LIVING FOR INDIA

A. C. UKIL,

CALCUTTA

ALTHOUGH social surveys for agricultural, urban and industrial living conditions have been carried out in different parts of India from time to time, the National Planning Committee was the first organisation which tried to lay down and define the minimum requirements of human life in India. Subsequently, the authors of the Bombay Plan defined these requirements according to their own ideas. Later on, Prof. Radhakamal Mukerji, the well known socio-economist, published his ideas regarding the requirements for Indian labour in the June, 1044 issue of the *Indian Journal of Social Work*. All these plans have been found to be incomplete from some point or other. The present note aims at further elucidation of the subject for the benefit of those who will be concerned with national planning in the coming years.

The democratic ideals of liberty and equality have been emphasized during the war which has just ended, and more than one statesman have stressed the need for freedom from want, and for equality of opportunity to every man for his complete development according to his abilities. Every man should have the opportunity to obtain (1) adequate food (qualitative and quantitative) for ensuring proper growth and maintenance of sound health, (2) shelter, which includes a house, furniture, clothing and a sanitary environment, (3) the opportunity of developing positive health and physical fitness, and (4) an education suited to his abilities and adapted to the requirements of national and world citizenship, along with facilities for fostering a spirit of exploration and adaptation to inventions, and the chance to develop and express his social and spiritual nature in an atmosphere of economic security—in work, in leisure and in retirement—to the extent which the wealth producing capacity of his country, for the time being, can offer.

It has been said that "it is probable that an overwhelming majority of diseases that occur throughout the world are due directly or indirectly to the lack of primary necessities, generally food, and many of the remainder are attributable to bad working conditions".[1] It is well known that if every family has a home in which it could live in decency, has food of the health standard and a feeling of absolute security, we would have an economically sound foundation upon which we could begin to build the new world. Such a programme has not yet been possible to achieve even in the wealthiest countries; for example, according to Sir John Orr,[2] one-third of the population in the United Kingdom and about 50 per cent in the U. S. A. did not enjoy food and shelter of the standard needed for health in the pre-war period. In most other countries, the proportion of the population which has never been adequately fed or adequately housed is even higher. Among backward peoples, only a relatively small proportion of the population has reached that economic level. It has also been demonstrated that the provision of food and housing amongst the poorest sections of the population up to the standard needed for health would reduce disease and improve national health and physique to a considerable extent.

It has been noticed that improvement of health depends on (1) efficient public health services, and (2) general rise in the standard of living, combined with the greater availability of foods of the right kind. The improvement of environmental sanitation represented by the supply of wholesome and sufficient water for drinking and washing, the prevention of pollution of water, the provision of sewerage and utilization of sewage, the healthiness of dwellings, the removal of nuisances, refuse and smoke, the inspection of food, the suppression of the causes of diseases and their regulation in the case of epidemics, the regulation of markets and the regulation of streets, highways and buildings, and the provision for hygienic burial or cremation of the dead should be considered as the minimum sanitary essentials[3] for civilized social life throughout the country. As such, it must be a charge on the State.

Indian background.—With only 2.5 per cent of the population employed in industries, agriculture remains the chief occupation in India giving employment to about 7/10th of her population. The bulk of the people, that is, nearly 28 out of 40 crores, live in 655,000 villages. According to the census of 1941, there are 465 agricultural labourers to 1000 cultivators. Due to the primitive condition of Indian agriculture, "the agricultural labourer occupies the lowest rung of the economic ladder. He is the first to suffer from famine and preventible diseases, and the first to be involved in chronic indebtedness."[4]

[1] J. D. Bernal—The Social functions of Science, Routledge and Sons Ltd., London, 1934.

[2] Sir John Orr—Foundations of the New World Order, *Nature*, April 11, 1942, p. 401.

[3] Report of the Royal Sanitary Commission of England, 1869-71.

[4] Radhakamal Mukerji—Food Planning for Four Hundred Millions, Macmillan & Co. Ltd., 1938.

The primitive nature and overcrowding of agriculture, slow industrialisation, low wages and unemployment of a large proportion of the population have all contributed to a high average mortality and low expectation of life. Under these circumstances, it is no wonder that the average weight of Indians is 20 to 30 per cent less than the standard weight for a particular age in the western countries, and that the average mining output for an Indian worker is 80 tons as compared to 300 tons in England and 589 tons in America. It has further been noticed that where wages are less, the efficiency of the workers is less and sickness, absenteeism and mortality rates are correspondingly higher.

In a survey of *landless agricultural labourers* in a Berar village, J. V. Bhabe[5] showed that the per capita income of a landless agricultural labourer was Rs. 31 per annum or 11 pies per day. 88 per cent of this income was from agricultural wages, 7 per cent from subsidiary occupations, 4 per cent from animals and 1 per cent from other sources. The main item of expenditure among this group was food. 72 per cent of the expenditure was on food ; 14 per cent on clothing ; 4.6 per cent on habits ; 3.1 per cent on special purposes and 6·3 per cent for general expenses; so that, out of every rupee spent by such a labourer, 11½ annas were on clothing; 9 pies on habits; 6 pies on special purposes and 1 anna on general items. According to the observations of Prof. Radha Kamal Mukerji, the expenditure on food consumes 70 to 80 per cent of the income ; fuel and lighting 5 to 10 per cent ; clothing 10 to 15 per cent ; house rent 10 to 15 per cent ; and miscellaneous 15 to 30 per cent. Among miscellaneous expenditure are included medical fees or medicines, education, intoxicants – tobacco etc., amusements and festivals, indebtedness and others. The percentage of the family budget on food in India is far higher than in the case of any other country in the world, including China. The lower standard of living also accounts for the preponderance of starch over proteins and the absence of animal products like milk and milk preparations in the diet. "The low standard of housing, the absence of ordinary furniture and utensils, the prevalence of illiteracy and ill-health and the high infantile and maternal mortality all point to the same direction. Only 9.5 per cent of the population aged 5 years and over is literate, even according to the low standard adopted (capacity to write a letter and to read the answer to it). The death rates and infantile mortality rates are much higher than in most civilised countries, and the expectation of life is correspondingly lower."[6]

[5] J. V. Bhabe—A survey of landless agricultural labourers in Shendurjana Bazar, a Berar village, *Indian Journal of Social Work*, Vol. III, 1942-43, pp. 437-450.

[6] Radhakamal Mukerji—Food Planning for Four Hundred Millions, Macmillan & Co., Ltd., 1938.

The average per capita income of an Indian is believed to be Rs. 65 per annum. It actually varies from Rs. 51 to Rs. 166 in rural and urban areas respectively.[7] In 1931-32, one half of the urban income was in the hands of less than 10 per cent of urban workers and even among the comparatively well-to-do classes, whose annual incomes exceed Rs. 2,000/- a year, 38 per cent of their number could claim only 17 per cent of their total income, while a little more than 1 per cent were in possession of 10 per cent of their total income. In rural areas, the income of the majority of the people is less than the average of Rs. 51/-. This is believed to be due to the fact that farmers holding less than 2 acres of land form a large proportion of the cultivator class. The wages of the agricultural labourer, during the pre-war period, was sometimes as low as 2 to 3 annas a day, while the cultivators were generally without any work for 3 to 6 months in the year. Daily wages of agricultural labour for women varied between 1½ to 4 annas and, in the case of children between 1 to 2 annas. It is no wonder that a large percentage of these workers exist below the subsistence level and thus become an easy prey to epidemics and famines.

An idea of the conditions prevailing in India can be obtained from the following description of the results of a social survey, subsidized by the Rockefeller Foundation, carried out at Closepet in the Mysore State[8] :—

"Twenty-five per cent of the families in this unit had an income under Rs. 5/- per month, 30 per cent had a monthly income of Rs. 5-10, 25 per cent between Rs. 10—15 p.m., 10 per cent between Rs. 15—20 p.m. and the rest above Rs. 20/- p.m., 30 per cent of the families had only one room, the rest more than one room. 1.5 per cent of the houses were provided with latrines; the rest had no latrines. 70 per cent of the houses had no windows and 25 per cent of the houses were unfit for habitation. 50 per cent of the houses were without drains and in 50 per cent of the houses the cattle were kept in living quarters. In 40 per cent of the houses the kitchen refuse was stored in the backward and in 15 per cent it was thrown into the streets. In 40 per cent of the houses, the sullage water was led into the backyard and in 50 per cent it was led into the street. There was very little provision for safe drinking water. In 30 per cent of the houses the manure was stored in the backyard and in the rest it was sent out to the fields."

The composition of *working class families* is more or less the same and, although their per capita

[7] Sir P. Thakurdas and others—A Plan of Economic Development, Bombay, 1944.

[8] A. C. Ukil—Some aspects of public health in India, Presidential Address at the Medical and Veterinary Research section, Indian Science Congress, 1941.

income is higher than in rural areas, the percentage composition of the items of expenditure in the family budget do not show much improvement. The average composition of families may be taken as the husband, or an earning male member, the wife, one non-earning dependent and two children or an average of 4 "consumption units". In a survey carried out by Gopala Rao in the Kolar Gold Fields,[9] the items of expenditure were found to be as follows:—

Food—55 per cent ; Fuel and lighting—5·5 per cent ; house rent—2 per cent ; clothing—5·1 per cent; liquor and *pan-sopari*—4 per cent ; interest on debts—15 per cent ; friends and railway fare—3·1 per cent ; marriages and other ceremonies—1·9 per cent ; barber, *dhobi*, etc.—1·4 per cent ; Education—7 per cent.

The average monthly expenditure on food per adult male was found to be Rs. 4/13/7 or 2 as. 7 pies per day. More than 96 per cent of the total number of families were found to be debt-ridden. The average indebtedness per family was roughly 9 months' income.

An earlier inquiry into working class family budgets in Bombay City (1932)[10] showed the average monthly family income of industrial workers at that time to be Rs. 50/1/7. The monthly items of expenditure per family were found to be as follows:—

Food—Rs. 23/6/10 or 46·6 per cent ; Fuel and lighting—Rs. 3-4-4 or 7·11 per cent ; house rent—Rs. 5-14-3 or 12·81 per cent ; clothing, footwear and umbrellas—Rs. 3-9-0 or 7·75 per cent ; bedding and household necessaries—1 anna or 0·13 per cent ; miscellaneous—Rs. 11-12-4 or 25·6 per cent.

The causes of indebtedness were shown to be as follows:—

Unemployment—26·67 per cent ; Marriages - 22·75 per cent ;
Sickness- 12·46 per cent ; Ordinary wants—9·71 per cent ;
Arrears to shopkeepers—8·04 per cent ;
House building and repairs—4·57 per cent ;
Funerals—3·19 per cent ; old outstanding debts—2·25 per cent ;
Strikes—2·1 per cent ; Other causes—8·26 per cent. =100 per cent.

Let us have an idea of what prevails in Bengal[11], where a recent famine carried away a large proportion of the population. There is an average of 5 persons per house or unit of family and there are 2·5 non-working dependents for every earner. According to the recent Famine Inquiry Commission, the number of families in Bengal, wholly or mainly dependent upon cultivation of land for their livelihood, is approximately 7·5 million in a population of a little over 60 million, or roughly 8 per cent of the population can derive their supply of cereals and possibly milk from the land they possess. 7 per cent of the population are non-working dependents on the working adult population and 5 per cent of the population constitute landless labourers. Approximately 2·5 per cent of the population are engaged in industry. The present extent of cottage industries and the income therefrom are not adequate to employ a large proportion of the people. There are hardly any industries or occupations subsidiary to agriculture which can help the people with uneconomical holdings to be "gainfully" employed. I believe this picture prevails, more or less, in other parts of India, except perhaps in the Punjab.

Items of the family budget.—Let us now consider the various items of the family budget (husband, wife, one non-working dependent, and two children =4 "consumption units"). They may be enumerated as follows:—

(1) Physiologically adequate dietary,
(2) Shelter,
(3) Clothing,
(4) Fuel and lighting,
(5) Purchase of cooking and other utensils,
(6) Toilet and washing requisites ; oil, soap, etc.,
(7) Tobacco, cigarettes and non-alcoholic beverage charges,
(8) Barber, washerman and tailor charges,
(9) Education, including books and stationery,
(10) Medical charges,
(11) Recreation, entertainment, newspaper, holidays and travel,
(12) Union rates or cess or other taxes,
(13) Ceremonies and festivals, including births, deaths and marriages,
(14) Repayment of debt incurred on land, agricultural implements, social events, prolonged illness, etc.,
(15) Bedding, mosquito curtain, shoes and umbrellas, and
(16) Social security against unemployment, social disasters, financial depression, illness or invalidity.

Some of these require amplification.

Food.—Among the items in the social machinery which can ensure to every individual in the community a standard of living adequate for the maintenance of health, food ranks first. Such food must contain "energy-yielding" constituents and "protective" constituents, vegetables, fruits, mineral salts and vitamins in proper proportions. It must be con-

[9] G. K. Gopala Rao—Labour in the Kolar Gold Fields, *Indian Journal of Social Work*, Vol. I, 1940-41, p. 230.
[10] Report on an enquiry into working class family budgets in Bombay City, 1932.
[11] A. C. Ukil—Food Problem in Bengal, SCIENCE AND CULTURE, Vol. XI, 1945-46, pp. 196.

sidered that food is not to be looked upon as merely consisting of rice, wheat, potatoes, fish, meat, eggs, vegetables and fruits, but of certain well recognised chemical entities such as carbohydrates, proteins, fats, minerals and vitamins in proper proportions, the intake of which will prevent a failure of growth and health and ensure the maintenance of positive health. Infants and growing children as well as expectant and nursing mothers need more of the protective foods and vitamins than the adult population, while the sick population have their special requirements. A balanced diet is far beyond the means of a large section of the population today. For the whole population the fluid milk supply is less than 1½ ounces per diem ; vegetables 3 ounces per diem ; and eggs—8 per year.[12]

The principles of dietetic requirements in the different age and sex groups of the population are given in the table on p. 198. It will be seen that a diet like this cannot be secured with less than Rs. 8/- per consumption unit per month in rural areas and Rs. 10/- per consumption unit per month in urban and industrial areas. This absorbs 40 per cent of the proposed family budget described below to ensure a minimum hygienic standard of living for this country. This percentage proportion can be reduced by applying scientific principles to agriculture and food technology. It will repay considerably to find out how Japan with 2·5 acres per family raises enough food, as compared to 3¾ acres in India. The folly of depending for increased production on a ploughing-up policy has been demonstrated in several countries. The scientific use of fertilisers, the conversion of inedible foods into edible ones, the use of by-products or waste products as food (*e.g.* yeast) and the production of foods and vitamins in the laboratory can furnish a way out, if the administrative authorities concerned develop a technical back-ground in their organisation.

The estimate of expenditure on food given by the authors of the Bombay Plan as well as by other workers has been found to be too low by us and are not applicable to all areas. The requirements for the production and distribution of such food to the population have been discussed in an earlier paper.[13] It should be the task of national planning to ensure a physiologically adequate dietary to the *whole* population. Speaking on nutrition, Sir John Orr expressed the following opinion in his Chadwick Lecture in 1935 : "It may be assumed that any Government would accept as the first essential the necessity for ensuring that every individual in the State shall be able to get a diet sufficient to maintain health. If a system of production and marketing of foodstuffs fails to do this, the State, through its medical and social services, must pay for treatment of those suffering from inadequate diet."

Shelter.—The house must provide for minimum floor space adequate for 6 ft. long beds at 6 ft. centres with sufficient space between two beds, besides 10 ft. of air column above the floor. The window area should be at least 1/15th of the floor area and the doors and windows taken together should form 1/7th of the floor area to provide for sufficient light and natural ventilation to permit of renewal of air, dissipation of heat and adjustment of humidity. According to the needs of various areas, the Planning Committee must think of cheap materials for the construction of heat insulating roofs and walls and for the abatement of noise. The construction of mud plinths and mud walls should be discouraged, as it almost always leads to the excavation of a pit where water collects in the rainy season and breeds mosquitoes. The accommodation provided must try to avoid physical and moral overcrowding.

The minimum house must contain at least 500 sq. feet—a kitchen about 40 sq. feet ; 2 rooms—12 × 12 feet or there abouts ; verandah or passage 12 × 6 feet, and a bathroom and a latrine. Both in Australia and U. S. A. the minimum housing requirements are laid down as 4 rooms, namely, a living room, a kitchen, 2 bedrooms, besides a bathroom. A minimum area for so-called habitable rooms has been defined by Government as 50—70 sq. ft. in Britain, 80 sq. ft. in Bengal, 120 sq. ft. in Ceylon and 103 sq. ft. in the Delhi re-housing scheme. No house should be allowed to be constructed in India which has less than 2 rooms, in the interests of separate sleeping accommodation for grown-up girls and for the isolation of patients suffering from infectious diseases. The cost of such a house will be about Rs. 615 (and if labour has to be hired = Rs. 800) in rural areas and about Rs. 1,800 in urban areas, at pre-war rates. If sufficient water supply is included and allowance is made for 20 per cent on rates and a net return of 5 per cent of the capital, the rent for this minimum house will be Rs. 3/4 in rural areas and Rs. 7/8 in urban areas. Rents lower than this will not be economical. If lower rents are charged, the balance must be found from some subsidy either from the State or from the employer. If the villager has to borrow money to build his house, provisions will have to be made in his Basic Wage to enable him to pay off the loan. In fixing the national minimum wage, it is better not to depend on outside subsidy. The design and the estimates of expenditure for a minimum house in rural and urban areas have been given by "Rustic"

[12] Lt.-Col. J. N. Morris, R.A.M.C.—Health of Four Hundred Millions, *Lancet*, June 16, 1945, pp. 743-748.

[13] A. C. Ukil—Food Problem in Bengal, SCIENCE AND CULTURE, Vol. XI, 1945-46, pp. 91-96.

in *Science and Culture*.[14, 15] The estimate of cost given by the Bombay Plan (Rs. 400/-) in rural areas and Rs. 800/- in urban areas will be found to be too low. 7½ per cent of the capital expenditure may be taken as the yearly cost of maintenance. The minimum rental for a home "fit for an ordinary family" was estimated by local authorities in Delhi in 1939 at Rs. 60 per annum and it was estimated that the lowest income which could pay such a house-rent would be about Rs. 300/- per annum.

In Bombay province (1938),[16] the living space in industrial areas was 28 sq. ft. per person in Bombay city, 43 sq. feet in Ahmedabad and 24 sq. feet in Sholapur. In Mysore, 50 per cent of the urban population (1938) lived in less than 60 sq. feet per person, while in Bangalore with a population of 250,000 the ratio reached 75 per cent, and in the Kolar Gold Fields (population 134,000) 83 per cent. Observations carried out in Bombay in 1940 show that infant mortality is higher in households where the accommodation is poor. In most of the industrial areas one-room tenements are the rule, and the overcrowding is so acute in the cities that streets and pavements are frequently used for sleeping at night.

Clothing.—The average consumption of cotton cloth per head in India is 16½ yards per annum, less than in Malaya, West Indies or the Gold Coast. The National Planning Committee laid down the requirements at 45 yards per capita per annum. The cost of woollen clothing (at least one rug and one sweater) is not included in this, neither is the expenditure on mosquito curtain and cotton for mattress. The cost of shoes and umbrella also is not included in this estimate. The average cost of cotton cloth may be calculated at 6 annas per yard.

Education.—Unless provision is made for free compulsory education by the State, provision for education of both children and adults will have to be made. If an allowance of school fees, varying between Rs. 1 to 4 per month is made, and Rs. 1/8 per month for books and stationery is included, then the cost of education, books and stationery per month will amount to Rs. 8/8. The estimate made by the Bombay Plan, namely Rs. 1/8 to Rs. 2 per child and -/8/- per adult per month, is far too low.

Medical charges.—The status of health in India today has been shown by the writer in his Presidential Address before the Medical and Veterinary Research Section of the Indian Science Congress in 1941. Medical services depend on the number and quality of trained personnel. At the present moment there is one qualified doctor for 10,000 persons, as compared to 1 doctor to 800 persons in Britain. One-third of India's 42,000 qualified doctors possess university qualifications and two-thirds are qualified after a shorter training with licenses granted by the State. There are 0·3 beds per thousand population as compared to 5 in England, 1·5 in Japan and 9·7 in the U. S. A.

The Government expenditure on environmental sanitation is incredibly small in comparison with the requirements. The expenditure on health in British India is 1/5th of that in the United Kingdom. Of 1474 towns in British India only 253 have a protected water supply. Rural water supply and sanitation are less protected than urban. The care of the sick is hardly practicable on account of the poverty and existing housing conditions.

The expectation of life at the present moment is the lowest in India. Mortality rates are very high and what is most disconcerting is that they are highest in infants. At the same time, experiments in Maternity and Child Welfare work, in controlled communities in India, have shown that wherever social services have been provided, the mortality rate has come down quickly. Of the deaths, about 25 per cent take place in infancy and over 50 per cent in individuals below the age of 15 years. 60 per cent of the people in England and Wales continue to live up to 60 years and above (1938), as compared to only 12 per cent in India. Under conditions described above, sickness rate is also very high. As has been stated before, the lack of primary necessities for healthful living is responsible for such conditions. Figures for health, disease and death rates will be found to correspond to Western European figures a little over a century ago. A rise in the standard of living in those countries corrected the defects and it is anticipated that the provision of a minimum hygienic standard of living in India will do the same.

The Bombay Plan lays down the following minimum essentials in respect of preventive and curative medicine:—

1. Proper arrangement in respect of sanitation and water supply in rural and urban areas,
2. Dispensaries for every village,
3. General hospitals and maternity clinics in towns;
4. Specialised institutions for the treatment of tuberculosis, cancer, leprosy, venereal diseases, etc.

So long as these are not provided by the State and so long as the standard of living is not improved, the cost of treatment will continue to be high. Considering the frequent requirements for medical atten-

[14] "Rustic"—The minimum requirements of a house in rural areas, SCIENCE AND CULTURE, Vol. X, 1944-45, pp. 300-302.

[15] *Idem*—Post-war housing and town-planning in India, SCIENCE AND CULTURE, Vol. IX, 1943-44, pp. 390-394.

[16] Lt.-Col. J. N. Morris—Health of 400 millions, *Lancet*, June 16, 1945, pp. 743-748.

tion, a charge of Rs. 2/- to Rs. 3/- per capita per month is not considered to be high.

Repayment of debt.—The burden of agricultural indebtedness was estimated to be Rs. 1,200 crores before the war. Unless the State helps in liquidating this debt, the basic minimum wage of a worker will have to provide for the repayment of debts. In our standard, therefore, we have provided for a repayment of debt at Rs. 5 per month per family in rural areas, Rs. 3 per month per family in urban areas, and Rs. 4 per month per family in industrial areas.

Provision for social security.—Provision for social security is essential in determining the national minimum wage. The wage earner may be sick, unemployed or superannuated and may become a burden, unless he is insured against these contingencies or has saved enough for these events. A sum of Rs. 4 per month must be provided for this purpose in his wages, so that he may have about Rs. 1,500 to his credit after working for 25 years. This may be sufficient to maintain a man and his wife for a few years.

Summary of the requirements for a minimum hygienic standard of Living.—(Estimated on the basis of a family consisting of the husband, wife, a non-working dependent and two children, or 4 consumption units).

The above estimates have been made on the supposition that the head of the family earns and looks after the wife and dependents, while the wife contributes her share by doing domestic work and by looking after the inmates. Where, however, the woman is also a wage earner, she will no doubt add to the total income of the family, but at the same time she will not be able to look after domestic work as thoroughly as if she had not been a wage-earner. There need not be any differentiation between a male and female worker as regards wages, provided they can do the same quality and quantity of work. It is estimated that their joint incomes will be able to meet the extra expenditure on domestic management (by keeping domestics) needed.

The above estimates of expenditure cannot be considered to be, in any sense, liberal. Perhaps, in certain cases, as the minimum basic wage of the country increases, the charges for services from barbers, washermen, tailors, etc. and the cost of commodities will also rise. The above estimate, therefore, cannot be said to have erred on the side of overstatement. The framers of the Bombay Plan want to treble the income per capita within fifteen years, provided their planning is put into operation. They further think that a per capita income of Rs. 74/- at pre-war prices is needed to secure a minimum standard of living. From our estimates given above, it will be seen that unless the per capita income is raised to 4 to 5 times the present level,[17] a minimum

[17] The Hon'ble Sir M. Azizul Huque (Man behind the Plough, The Book Company, Calcutta, 1939) was of the opinion that the mimum requirements of peasant life could be met by doubling the pre-war per capita income.

SUMMARY OF REQUIREMENTS FOR A MINIMUM HYGIENIC STANDARD OF LIVING

(Cost per family of husband, wife, a non-earning dependent and 2 children = 4 consumption units, per month, at pre-war rates)

	Rural		Urban		Industrial	
	Rs. A. P.	%	Rs. A. P.	%	Rs. A. P.	%
1. Physiologically adequate dietary	32 0 0	40·0	40 0 0	40·0	40 0 0	40·0
2. Shelter (rent or interest on cost of cons. & repair) ...	3 4 0	4·2	7 8 0	7·5	7 8 0	7·5
3. Clothing (@ 45 yrds. per capita, per annum) ...	5 7 6	6·9	7 0 6	7·0	7 0 6	7·0
4. Fuel and lighting	3 0 0	3·75	3 8 0	3·5	3 8 0	3·5
5. Cooking and other utensils	0 8 0	0·6	0 8 0	0·5	0 8 0	0·5
6. Toilet and washing requisites	2 0 0	2·5	2 0 0	2·0	2 0 0	2·0
7. Tobacco, cigarettes and betel and betelnuts ...	2 8 0	3·1	2 8 0	2·5	2 8 0	2·5
8. Barber, washerman and tailoring charges	2 8 0	3·1	4 0 0	4·0	4 0 0	4·0
9. Education, including books and stationery	8 8 0	10·6	8 8 0	8·5	8 8 0	8·5
10. Medical charges	2 0 0	2·5	3 0 0	3·0	3 0 0	3·0
11. Recreation, newspaper, holidays and travel	4 0 0	5·0	6 0 0	6·0	5 0 0	6·0
12. Union rates or cess, other taxes	0 4 0	0·3	0 8 0	0·5	0 8 0	0·5
13. Ceremonies, festivals, including births, deaths and marriages	3 8 0	4·4	3 8 0	3·5	3 8 0	3·5
14. Repayment of debt (incurred on land, bullocks, agricultural implements, social events, prolonged sickness, etc.	5 0 0	6·25	3 0 0	3·0	4 0 0	4·0
15. Bedding (cotton), mosquito net, shoes, umbrellas, woollen goods	1 8 0	1·8	4 7 6	4·5	4 7 0	4·5
16. Social security (against unemployment, social disasters, financial depressions, illness or invalidity) ...	4 0 0	5·0	4 0 0	4·0	4 0 0	4·0
TOTAL	80 0 0	100	100 0 0	100	100 0 0	100

hygienic standard of living for a large majority of the population of this country cannot be secured. If a basic wage has to be laid down, it must be on some sort of basis as above. It must be pointed out, however, that economic advance does not automatically pay dividends in welfare, unless the income per capita and the welfare measures are equitably distributed among all classes of the population.

The framers of the Bombay Plan propose two classes of measures for securing a minimum standard of living, namely, (1) those which would raise the general level of income and (2) those that would reduce the burden of individual expenditure on consumption goods and services, that is, the cost of living. In order to increase the general level of income they suggest the following measures:—

1. Provision of full employment, that is, to ensure for every grown-up person, suitable opportunities for earning his or her livelihood.
2. Increase in efficiency.
3. Improvement in urban and rural wages.
4. Security of agricultural prices and development of multipurpose cooperative societies.
5. Reform of the land system.

They further propose the following measures for reducing the cost of living:

1. Provision of free social services, as for example, primary and middle school education, adult education and medical treatment.
2. Provision of essential utility services, as for example, electricity and transport at low cost.

A minimum wage standard.—It has been stated that every Indian family has a non-working adult dependent, basides the wife and two children. Family budget studies have shown that most of the members of a family group depend on the earnings of the head of the family. Further, in India, the wife or daughter of the Indian worker hardly counts as a wage earner. In other countries, as for example, in Australia, the earnings of the children and wife of an employee are not taken into account in fixing the basic wage of an adult male employee. A minimum wage that is to be offered to rural, urban and industrial workers, therefore, must enable them to have a reasonable standard of living in terms of the requirements explained above. We have tried to show that the minimum monthly wage for an adult male rural, urban and industrial worker should be Rs. 80/-, Rs. 100/- and Rs. 100/- respectively. This figure will be found to exceed the estimate made by Prof. Radha Kamal Mukerjee[18] in the case of indus-

DIETETIC REQUIREMENTS AT VARIOUS AGES (BENGAL)

Sex	Age	Wt. (lbs.)	Physiological state	Hrs. of work & type of work	Basic Calorie requirement	Addl. Calorie	Total Calorie	Proteins (grms.) Animal	Proteins (grms.) Vegetable	Fat (grms.)	Carbohydrate (grms.)	Calciums (grms.)	Phosphorus (grms.)	Iron (mgms.)	Carotene & Vit. A (mgms.)	Vit. B_1 (mgms.)	Vit. B_2 (mgms.)	Nicotinic acid (mgms.)	Vit. C (mgms.)	Vit. D Micro-grms.
Female	30	100	Pregnancy 4-9 months	6 hrs. light	2600	300	2900		72 72	70	424	1·5	1·75	15·0	1·5	1·5	2	25	50	25
Female	30	100	Lactating	6 hrs. light	3000	300	3300	62	62	70	544	1·5	1·75	15·0	1·5	1·5	2	25	50	25
Adult male	30	120	...	8 hrs. light	2500	400	2900	60	60	70	475	0·75	1·00	10·0	1·0	1·0	1	10	50	12
Adult male	18	100	...	4 hrs. light	2500	200	2700	37	37	70	444	0·75	1·00	10·0	1·0	1·0	1	10	50	12
Adult male	16	80	...	4 hrs. light	2500	200	2700	44	44	60	452	0·75		10·0	1·0	1·0	1	10	50	12
Child	12	60	...	4 hrs. light	2400	200	2600	45	15	45	489	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	10	50	...	4 hrs. light	1950	200	2150	33	12	37	409	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	8	45	...	4 hrs. light	1700	200	1900	33	12	33	356	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	6	40	...	4 hrs. light	1500	200	1700	35	15	30	308	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	3	26	...	...	1400	100	1500		...	20	291	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	2	22	...	...	1200	50	1250	49	...	16	228	1·0	1·25	12·5	1·5	1·5	2	25	50	25
Child	1	16	...	...	1100	...	1100	40	...	15	201	1·0	1·25	12·5	1·5	1·5	2	25	50	25

Note: Up to the age of five, most of the protein should be of animal origin, preferably milk. For age period 5–15 years and in expectant and nursing mothers, 50%-of the protein requirement must come from animal sources. For adults, one-third of the total protein required must come from animal sources. The remainder may be obtained from vegetable sources, such as beans (including soyabeans), pulses, groundnuts, etc.

For individuals doing *moderate work*, add 75–150 calories for each hour of such work; for *heavy work*, add 150—300 calories per hour of such work; and for *very heavy work*, such as sports, digging, etc., add 300–400 calories for each hour of such activities.

[18] Radha Kamal Mukerjee—A national minimum welfare standard for Indian labour, *Indian Journal of Social Work*, Vol. V, No. 1, June, 1944.

trial workers, and that of the Bombay Textile Labour Inquiry Committee (1941).

We do not propose to enter into intricate interconnected subjects which would help in ensuring the above standard of living, but we hope that the National Planning Committee or any committee which proposes to lay down a minimum hygienic standard of living will take into consideration the points we have stressed in this note. A plan which provides for adequate food and clothing, a healthy dwelling, a sanitary environment and education and social security for every family cannot be left to private enterprise. It must be realized that if we can bring the food and housing of the poorest sections of the population up to the standard for health, we shall be able to reduce the incidence of disease and improve national health and physique to a considerable extent. As we proceed along the path, it will be found that a great part of our social and public health services and most of the charities will gradually become unnecessary.*

* I wish to express my grateful thanks to Prof. K. Subrahmanyan, Professor of Sanitary Engineering, and Prof. G. Sankaran and his staff of the Department of Nutrition and Bio-chemistry, All India Institute of Hygiene and Public Health for much useful advice and help in determining the standards.

BOOK REVIEWS

A Treatise on Physical Chemistry. Volume I—(Atomistics and Thermodynamics) –Edited by Prof. H. S. Taylor and Prof. S. Glasstone. Pp. vi + 679. MacMillan & Co. Ltd., London, 1942. Price $42.

The book under review is the *first volume* of a 'Treatise on Physical Chemistry'—a co-operative effort by a group of Physical Chemists', third edition. The editors are Prof. H. S. Taylor of the University of Princeton and Prof. S. Glasstone of the University of Olkahoma. The Treatise originally appeared in 1924 in two volumes, and the second edition was published in 1930. The phenomenal progress in physical science during the last two decades due largely to the impact of quantum mechanical ideas, has made it necessary for the editors to extend the original treatise of two volumes into one of five volumes of which the first volume entitled 'Atomistics and Thermodynamics' has so far appeared. The titles of the next four volumes will be, it is proposed, 'States of Matter', 'Chemical equilibrium', 'Chemical Kinetics' and 'Molecular Structure'. The complete work will, therefore, cover almost everything of atomic and molecular physics and much besides it. With the unravelling of the wave and the particle aspects of physical entities, and Bohr's principle of complimentarity with its most profound consequences, has come the collapse of the barrier between physics and chemistry, and it has happened without our almost noticing it. Physical chemistry is no longer a 'borderland subject': the borderline has practically vanished—perhaps its ghost is still there—and physical chemistry seems to have no frontiers save those of physics and chemistry. The compartmentalization of science which is essential for our feeble minds to make progress conflicts with its natural unity, and stagnation is only avoided by a process of 'gerrymendering' instead of physics and chemistry it seems, the new compartments are to be atomic and molecular phenomena and matter in bulk (strength and structure of materials)

To return to the volume under review it comprises four chapters dealing respectively with the (*i*) Atomic Concept of Matter, (*ii*) Quantum Theory of Atomic Spectra and Atomic Structure, (*iii*) the First and Second Laws of Thermodynamics and (*iv*) the Third Law of Thermodynamics, and Statistical Mechanics. Values of physical constants (Brige 1941) are given in the appendix.

Professor Taylor himself contributes the first chapter. It traces the evolution of the concept of the atomistic structure of matter and electricity from the time of Dalton. It gives a short but critical discussion of the various methods for determining the electron charge. It next describes Rutherford's discovery of the nucleus. It may be remarked that it was only after the discovery of the nucleus that unambiguous distinction could be made between atoms and molecules. The Gamow-Gurney-Condon theory of alpha disintegration finds a place, but the description is all too crude and will hardly make any sense to the uninitiated reader. May be, a fuller treatment of the fundamental problem of transmission across potential barriers will be included in the volume on Chemical Kinetics. Mass spectrographs occupy a few pages and an excellent discussion is given of the thermal

diffusion and the other methods for separating isotopes. We then pass on to nuclear reactions and artificial radioactivity. Sixteen pages of tables summarize the data on induced radio-activity. The last article of less than a page is devoted to the thermonuclear processes and it describes Bethe's carbon-nitrogen cycle which operates in stellar interiors and accounts for the luminosity of 'main-sequence' stars. A somewhat fuller account of this most important work in astrophysics during recent years would have been very welcome. The chapter of 117 pages provides a useful summary of atomic and nuclear phenomena. References are copius and add to the value of the chapter.

The Second Chapter occupying about half the book is by Dr Dushman. It gives a short but lucid introduction to the fundamentals of spectroscopic notation. It next deals with the atomic number and X-ray levels: there is some repetition of what is already described in the first chapter, but in a book of this kind it is unavoidable and is within limits also desirable. [Figures 2, 3 and 4 of chapter 1 are reproduced again as figures 1, 10, 1,11, and 1,12]. The interpretation of the refraction of light on corpuscular and wave theories leads to the fundamental relations between wave length and momentum. Schrödinger's equation and its application to simple problems is described. The phenomena of the collision of electron with atoms are dealt with in some detail. The chapter closes with the quantum theory of valency.

The last two chapters deal with thermodynamics. The chapter on the First and the Second Laws is by Prof. Taylor, and Prof. Aston has contributed the chapter on the Third law.

The history of the development of thermodynamics, is a very interesting and illuminating study and a critical historical introduction (on the lines of Epstein's thermodynamics, chapter I) might with advantage have been included in the Chapter on the First and Second Laws of thermodynamics. As in most text books, the fundamental concepts of temperature and heat are assumed to be intuitively known to the reader, and are not critically discussed. It seems to the reviewers that the time has now come when any serious text-book on thermodynamics should provide a systematic and logical treatment of the basic thermodynamical concept. Classical thermodynamics is a complete and beautiful structure and there is much in Caratheodory's axiomatic treatment that should find a place in (advanced) textbooks. As an illustration of the confusion which is liable to arise when thermodynamic terms are not carefully defined we may note the following:—On page 456 an *adiabatic* process is defined as one without heat absorption and the Joule-Thomson effect is thus considered to be an adiabatic process. But on page 462 the *adiabatic* expansion of the ideal gas is considered and the relation pv^{γ}=constant is obtained. No distinction is thus made between processes that are merely thermally isolated (Joule-Thomson effect) and process that are thermally isolated as well as reversible (isocntropic process). The chapter gives an account of the various thermodynamic functions and their applications.

The last chapter deals with the Third Law of thermodynamics and statistical mechanics. The classical, Fermi-Dirac and Bose-Einstein statistics are discussed in detail. The various topics treated include ortho- and para-hydrogen, cooling by adiabatic demagnetization, thermodynamic temperature scale below 1°K, and liquid HeII and Bose degeneracy (The coefficients of $T_0/T^{9}/_{2}$ in equations (74·31) and (74·36) are not correct; they are respectively 0·000197 and 0·0069 instead of 0·0114 and 0·040). The discussion of absolute entropy is excellent.

The book is a very valuable addition to current literature and will serve as a most useful work of reference for chemists as well as physicists. It should find a place in all physical science libraries.

D. K. and *A. R.*

Hayfever Plants—By Roger P. Wodehouse (A new series of plant science books, Edited by Frans Verdoorn, Vol. XV). Pp. xix + 245 (73 figures and 10 tables). Waltham, Mass, the Chronica Botanica Co.; Calcutta, Macmillan & Co., Ltd., 1945. $4.75.

Hayfever is not a true fever and hay asthma is a better name because the condition in the nose and throat of the affected person has resemblances to that in the bronchial tubes in true asthma. Until recently it was erroneously ascribed to the effluvium of new-cut hay. While some persons are affected when hay is ripening others are not affected from hay but suffer when certain other plants bloom. The disease usually occurs in early spring, early summer and late summer and like asthma and urticaria it is one of the diseases which is now called "allergic disease". The persons affected suffer the whole of summer which render their lives miserable. It is usual for the sufferer to avoid agricultural districts as it has been found that the pollen of grasses *e.g.*, Timothy-grass (*Phleum pratense* L) commonly cultivated for hay and growing wild in fields and meadows almost throughout North America along with several other grasses and weeds cause the disease. The first step in the treatment is to discover what pollen is to blame and this is done by a simple test by the specialist.

The author, an associate director of research in allergy, Lederle laboratories, New York, in his classical work entitled "Pollen Grains", McGraw Hill publication (1935), briefly indicated the botanical facts of hayfever in terms of their clinical significance.

Since then, considerable data had accumulated more on the clinical than botanical aspects of hayfever and the facts botanical remained scattered and mingled with fancies and no one other than a botanist could be expected to separate them. This has been admirably presented, in the book under review by the author, who enumerates the hayfever plants, their appearance, distribution, time of flowering and their role in hayfever, with special reference to North America.

The first part of the book is devoted to pollen and pollination and the allerginic toxicity of the pollen causing hayfever, as well as the description of the plants known to cause hayfever, showing where they grow, when they flower and the characteristics which make them hayfever plants. Of the gymnosperms few are known to produce hayfever causing pollen and the bulk of the book is devoted to the angiospermous hayfever plants. Among the monocotyledons, grasses constitute the main plants causing contamination and spread of this allergic disturbance, while in the dicotyledons, it is noteworthy that the Compositae have the largest number of plants causing hayfever and next in importance are oaks, birches and maples.

The second part of the book is geographical, dealing with hayfever by areas, throughout the United States, Canada, and Mexico.

Illustrations of hayfever-causing-plants and their pollen grains, a useful glossary and an extensive bibliography are special features of the book, which can be profitably utilized by the botanist, the palynologist, the medical men and the laymen.

This is the fifteenth volume in the series of "A new series of plant science book" edited by Frans Verdoorn and the editor must be singled out for special mention in bringing out these classics in botanical literature amidst the turmoil of war.

A. K. G.

How Man Became a Giant—By M. Ilin and E. Segel. Translated by Beatrice Kinkead. Illustrated by A. Komarov and E. A. Furman. Kitabistan, Allahabad. Pp. 278. Price Rs. 5/4.

The authors give a fascinating account of the different stages of the evolution of man. How with the advent of the Ice Age our primeval ancestors took to terrestrial mode of living ; how by their power of adaptation they, of all animals, managed to stand the rigours of the environment by their devices of making skin-garments and of producing fire, how again by inventing implements of stone and bone and by pack work they added to their food supply by the carcasses of such huge monsters of the forest as the mammoth and the bison. The domestication of animals and the cultivation of cereals as a contribution to food supply have not escaped their notice and the authors have nicely shown how our ancestors became potters, miners, and metallurgists and ultimately extended their domain in waters with the necessary outfits of floats and dugouts.

Equally fascinating are their accounts of the evolution of speech and language and the evolution of their superstitious and religious beliefs and practices.

One might not agree with a few of the authors' portraitures, but they do not materially matter much to those for whom the book is intended.

All through the authors spread a spell in their writing and the novelic way of description gives a living and fascinating picture to the whole account.

The translators should no less be congratulated for their lucid style and mastery of translation.

T. C. R. C.

The Donnan Membrane Equilibrium—By S. G. Chaudhury, D.Sc. Published by A. P. Bhattacharya, Howrah. Pp. 111 + xv, 1945. Price Rs. 10/-.

The monograph entitled "The Donnan Membrane Equilibrium" by Dr S. G. Chaudhury, consists of 111 pages divided into eight chapters.

A considerable portion of the book has been devoted to the theoretical treatment of the subject. Besides giving an account of the work of Donnan and co-workers, the author has attempted to develop a theory of his own, the validity of which remains yet to be established.

Leaving aside the theoretical portion, the book contains a detailed account of the application of membrane equilibrium to various problems and will prove quite useful to those who are interested in the subject. Much useful references to relevant literature will also be found in the book.

So far as the get up and printing of the monograph are concerned, there is much room for improvement.

B. N. G.



LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

STUDENTISED TESTS OF LINEAR HYPOTHESES

In an earlier paper by the author[1] the general theory of linear estimation and tests of significance when the variances and covariances are known have been discussed. The procedure, as outlined there, is to take a linear compound of the parametric functions subject to some restrictions and maximise a certain expression of their estimates. The object of the present note is to demonstrate as to how the same principle gives the corresponding tests of significance when the variances and covariances are not known. Only those cases *which are new* are discussed here and the author hopes to publish a unified theory of tests of significance of linear hypotheses in the coming issue of *Sānkhya*.

Lemma. If T_i and a_{ij} $(i=1, 2, \ldots k\ ;\ j=1, 2, \ldots k)$ are stochastic variates with the probability distribution

$$\text{const. } \exp\left(-\tfrac{1}{2}\Sigma\Sigma\alpha^{ij}T_iT_j\right)\pi\, dT \exp\left(-\tfrac{1}{2}\Sigma\Sigma\alpha^{ij}a_{ij}\right) |a_{ij}|^{\frac{m}{2}}\pi\, da_{ij}$$

then the distribution of $V^2=|T_iT_j+a_{ij}|/|a_{ij}|$ is given by

$$\text{const. } (V^2)^{\frac{k-2}{2}}\ (1+V^2)^{-\frac{m+k+1}{2}}\ dV^2 \quad \ldots \quad (1)$$

Problem 1. A sample of size n, $((x_{ij}))$ $(i=1, 2, \ldots p,\ j=1, 2, \ldots n)$ from a p variate population being given, to test the hypothesis that the means of the p variates are the same we choose a linear compound

$$l_1x_1+\ldots+l_px_p \quad \ldots \quad (2)$$

such that $l_1+l_2+\ldots+l_p=0$ and maximize the statistic

$$V^2=(\Sigma\, l_ix_i)^2/\ \Sigma\Sigma l_il_j\,a_{ij} \quad \ldots \quad (3)$$

where a_{ij} is the sample covariance between the i-th and j-th variates. The maximum value comes out as the root of the determinental equation

$$\begin{vmatrix} x_ix_j-V^2\,a_{ij} & \vdots & 1 \\ \cdots\cdots & \vdots & \vdots \\ & \vdots & 1 \\ 1 \quad \ldots\ldots \quad 1 & \vdots & 0 \end{vmatrix}=0 \quad \ldots \quad (4)$$

The distribution of V^2 is given by (1) with $k=(p-1)$ and $m=(n-p)$

Problem 2. A sample of size n, $((x_{ij}))$ $(i=1, 2, \ldots p,\ j=1, 2, \ldots n)$ and $((y_{ij}))$ $(i=1, 2, \ldots p,\ j=1, 2, \ldots n)$ is available from a $2p$ variate population. To test the hypothesis

$$E(x_i)=E(y_i)\ \ i=1, 2, \ldots p \quad \ldots \quad (5)$$

we use the statistic

$$V^2=|(x_i-y_i)\ (x_j-y_j)+b_{ij}\ |\ /\ |\ b_{ij}\ | \quad \ldots \quad (6)$$

where $n\ b_{ij}=\sum_r (x_{ir}-y_{ir})\ (x_{jr}-y_{jr}-x_j+y_j)$

which is distributed as (1) with $k=p$ and $m=(n-p-1)$

Problem 3. There are p samples of sizes $n_1\leqslant n_2\leqslant n_3 \ldots \leqslant n_p$ drawn independently from p populations. The hypothesis to be tested is that the means of the populations are the same *when it is known that the variances are not the same.* The observations from the i-th population are taken as the observations on a variate (i-th variate) and the correspondence among the first, second and the p-th variates thus constructed is achieved by a random arrangement or by keeping the sequences in which the samples are drawn. For this (n_i-n_1) observations have to be omitted from the i-th sample. The variance covariance matrix calculated out of this may be denoted by (a_{ij}). Let $x_1, x_2, \ldots x_p$ be the means calculated for the p populations *on the full sample values.* Taking a linear compound $\Sigma l\sqrt{n_i}\,x_i$ such that $\Sigma l_i\sqrt{n_i}=0$ we maximize the statistic

$$V^2=(\Sigma l_i\sqrt{n_i}\,x_i)^2/\ \Sigma\Sigma n_1\ l_i\,l_j\,a_{ij} \quad \ldots \quad (7)$$

Then V^2 comes out as the root of the equation

$$\begin{vmatrix} \sqrt{n_in_j}\,x_ix_j-V^2n_1\,a_{ij} & & \sqrt{n_p} \\ & & \\ \sqrt{n_1} & \ldots\ldots & V\,n_p \end{vmatrix} \quad (8)$$

and the distribution is given by (1) by putting $k=(p-1)$ a and $m=n-p$.

Problem 4. Given samples of sizes n_1 and n_2 from two p-variate populations we have to test the hypothesis that the mean values for the corresponding variates are the same *when it is known that the dispersion matrices are not the same.* Following the arguments indicated above we get the suitable statistic as

$$V^2=|(x_i-y_i)\ (x_j-y_j)+n_1\ a_{ij}|/|n_1\ a_{ij}| \quad (9)$$

where x_i and y are the means of the i-th characters for the first and second populations calculated *on the full sample values,* and $((a_{ij}))$ is the matrix of variances and covariance obtained from the quantities

$$\left(\left(\frac{x_{ia}}{\sqrt{n_1}}-\frac{y_{ia}}{\sqrt{n_2}}\right)\right) \quad (10)$$

where x_{ia} and y_{ia} are the observed values for the i-th character in the two populations and the correspondence is achieved either in a random manner or keeping the sequence in which the samples occur and omitting (n_2-n_1) observed values for each of the characters from the 2nd sample. The distribution of is same as (1) with $k=p$ and $m=n_1+n_2-p-1$.

Problem 5. Given three p-variate populations π_1, π_2, π_3 with identical dispersion matrices to test the hypothesis with π_2 is nearer to one than to the other, on the basis of samples of sizes n_1, n_2 and n_3 we use the statistic

$$V^2=\left|\sum_{6}^{n}(2y_i-x_i-z_i)(2y_j-x_j-z_j)+d_{ij}\right|/\left|-d_{ij}\right| \quad \ldots\ldots\ldots (11)$$

where $4/n_2+1/n_1+1/n_3=6/n$ and

$d_{ij}=(n_1 a_{ij}+n_2 b_{ij}+n_3 c_{ij})$ where $((a_{ij}))$, $((b_{ij}))$ $((c_{ij}))$

are the sample dispersion matrices for the three populations. The distribution of V^2 comes out from (1) on substituting $k=p$ and $m=(n_1+n_2+n_3-3-p)$.

A variety of other problems will be given in a paper to be published shortly.

C. RADHAKRISHNA RAO

Statistical Laboratory,
Presidency College,
Calcutta, 17-7-1945.

[1] Rao, C. R., On linear estimation and tests of linear hypothesis. *Current Science*, 13, 154, 1944.

ABSORPTION IN DIFFERENT SUBSTANCES OF THE PENETRATING COMPONENT OF COSMIC RAYS RESPONSIBLE FOR MULTIPLE TRACK PRODUCTION IN PHOTOGRAPHIC EMULSION

WE have for several years been engaged in the investigation of single and multiple ionization tracks produced in Ilford New Halftone plates, which have been found to be specially suited to the detection of cosmic ray particle tracks. Our investigations have been concerned (*i*) with the measurement of the average mass of the particles responsible for the production of single and pair tracks. The mass values were found to vary between 150 and 250 mm. which lie within the range of accepted values for meson mass. (*ii*) It was consequently assumed that tracks of multiplicities between 3 and 7 found in the photographic plates were also due to multiple meson production. In some of the multiple tracks are found in which the mean grain spacing along the tracks were $<2\cdot4\times10^{-4}$ cm.; such tracks were for reasons stated in our previous publications rejected as not being due to mesons. The energy E of a meson multiple containing n tracks is taken as $E=n.\,\mu c^2+\Sigma k_n$; where $\mu c^2=10^8$ eV is taken as the meson mass energy and Σk_n the k.E. of the mesons, which for the given meson tracks vary between 10^6—10^7 eV, and as such are negligible in comparison to the meson mass energy.

An energy distribution curve for the multiple meson production in the emulsion was found to have a maximum for $n=3$, *i.e.*, for meson production energy of $\sim3\ \mu c^2$ which is equal to $3\cdot10^8$ eV. It was pointed out by us[1] that the energy distribution curve agree qualitatively with the meson energy spectra given in a recent paper[2] by Hamilton, Heitler and Peng *viz.* in both the energy distribution curve had a maximum at $\sim3\ \mu c^2$ energy. The theory proposed by Heitler *et al* is based upon the assumption that the primary cosmic ray particles are protons and that each nucleon (proton/neutron) carries a meson field, which is also the field of interaction between nucleons existing in atomic nuclei. During a close collision between a fast moving nucleon of energy E and a stationary one, a portion of the meson field of energy E is radiated away to form single or multiple mesons. It appears reasonable therefore to assume that the penetrating cosmic ray particles responsible for multiple track productions in photographic emulsions are primarily nucleons. There are also evidences accumulating that photons can also produce mesons but we are not interested in it in this communication.

The characteristics of the effective penetrating cosmic ray particle can also be determined from a study of their absorption in different substances. It is the purpose of the present communication to report on the results obtained by us. The method utilized was to keep Ilford Halftone plates exposed to cosmic radiation at Darjeeling (7000 ft.), Sandakphu (12,000 ft.) and Phari Jong (14,500 ft.) under (*i*) air, (*ii*) 30 cm. thickness of paraffin and water and (*iii*) under different thicknesses of lead upto 5 cm. The total number of tracks, checked to be due to mesons, which appear per cm.^{2} of surface when exposed for 100 days to cosmic rays were measured on the different plates, and from the results of the measurements the absorption of the primary particle of average energy 10^9 eV per cm. in the different absorbers were calculated in the following way.

Consider a layer of thickness t of an absorber made up of paraffin, above and below which photographic plates with emulsions of thickness δt equal to 70×10^{-4} cm. are kept exposed to cosmic radiations. We assume that within the limits of our measurement, α the co-efficient of absorption of the radiation is independent of its energy and therefore $E=E_0e^{-\alpha t}$ If E_0 is the energy incident on the upper photographic plate per cm.^{2} area per hundred days, and E on the lower plate, N_1 and N_2 are the total number of tracks per unit area for the same time on the upper and lower photographic plates respectively, then $N_1\times10^8=\alpha_0E_0\delta t$ and $N_2\times10^8=\alpha_{04}E\delta t$.

Since both paraffin and the photographic emulsion contain hydrogen and carbon abundantly, we take the absorption co-efficient to be approximately the same in both. From these equations we can get the value of E_t, the energy absorbed in thickness t of absorber and also of $E^1 = \frac{E_t}{t}$ the energy absorbed per unit thickness of an absorber.

If N is the number of penetrating particles, effective in multiple meson production, incident per unit area in the given time, then E_{02}/N is the average energy of each particle and E^1 N is the energy loss per cm. track length in the given absorber. It can be shown that protons (neutrons) and not mesons are primarily responsible for such track production. Estimates for the proton fraction present in the primary penetrating particles vary from 2 to 7 per cent. We have taken it to be 5 per cent. Christy and Kusaka's[3] formula has been used to calculate the number of penetrating particles present at different altitudes ; we have taken the cut off energy to be $3\mu c^2$. The energy loss in different absorbers have been expressed in Table I as multiples of the ionization loss of protons of average energy 10^9 eV in

TABLE I

Lead	Air	Paraffin	Water
4·6	7·5	28 ; 29	41

corresponding media—the reasons for doing so is explained below :

The energy loss in the different media appear to be inversely proportional to the effective atom masses of the absorbers, being largest in hydrogen containing substances. This gives additional support to the view that the primary effective particle is proton (neutron).

Heitler *et al* have shown that the formula deduced by them for energy loss of high energy proton ceases to be valid for energy of the order of proton mass *i.e.*, 10^9 eV. At this stage though the meson production is negligible, compared to its production at higher energies, the energy loss is still much greater than that due to ionization ; a rough estimate shows that it would be ten times the latter. In addition to the energy losses suffered by the primary nucleon due to ionization and meson production, a part of its energy will be transferred as momentum to the stationary nucleon. The transfer will be greatest when the latter is free: if the latter forms part of a heavy nucleus of mass M, the average momentum transferred will be proportional to 1/M.

The relative absorption co-efficients are all of the expected order of magnitude. The low value for lead may be due to the fact that in lead a multiplication of photons takes place, and these are known to be effective in the generation of mesons. The 5 cm. of lead is not sufficient to cut off these secondary photons, which produce additional mesons in the photographic emulsion. The absorptions in paraffin obtained at two different altitudes of 14,500 and 12,000 ft., are in fair agreement with one another. It is not possible to interpret the abnormally high value for water. More plates will be sent up when fresh Ilford plates become available. Last year we exposed a pair of old Ilford plates one above and the other below 18 cm. of carbon at Sandakphu, with a view to separating the absorption due to hydrogen from that due to carbon in paraffin. The plates were found to have become insensitive.

In conclusion it may noted that the agreement obtained between the prediction of Heitler's theory and our experimental results depends upon our assumption, based upon those of Johnson,[4] Wilson[5] and others that at the altitudes of our measurements about 5 per cent of the penetrating particles are protons. A detailed account of the investigation will be published by one of us (B.C.) elsewhere.

D. M. Bose
Bibha Choudhuri

Bose Research Institute,
Calcutta, 3-8-1945.

Bose, Choudhuri and Sinha, *Phys. Rev.*, *65*, 341, 1944.
Hamilton, Heitler and Peng, *ibid.*, *64*, 78, 1943.
Christy and Kusaka, *ibid.*, *59*, 414, 1941.
Johnson, Barry, Shutt, *ibid.*, *57*, 1047, 1940.
Wilson, J. G., *Proc. Roy. Soc. A.*, *172*, 517, 1941.

ASSAY OF INDIAN IPECACUANHA

Chopra and Mukerji[1] carried out a comparative estimation of the total alkaloids and emetine content of the Brazilian, the Columbian and the Indian Ipecac roots and concluded 'that the emetine content of the Indian root compared very favourably with the Brazilian root'. Later work seemed to indicate that the results obtained by using the older method of analysis might have been invalidated because of the readiness with which the emetine underwent decomposition. Much attention has since been given to the chemical method of estimating the alkaloid content of Ipecac. Sometimes high results are obtained due to the base, cholin, which exists in the root as an insoluble tannate when the assay of Ipecac is conducted by exhausting the root with acid solvents. The B. P. 1914 method directly determines the total alkaloids from the residue. This method has since

been reported to yield higher results and has since been modified by the B. P. 1932 method which determines the total alkaloids and the non-phenolic alkaloids. In the 6th Addendum to the B. P. 1943, the standard of non-phenolic alkaloids has been lowered up to 55 per cent (*i.e.* 1·10 per cent of the total alkaloids, 2 per cent). The U. S. P. XII, 1942 has set up a standard of not less than 2 per cent of the total ether-soluble alkaloids for Ipecac. In view of the fact that a better and more accurate method of assay for Ipecac has been available, it was considered desirable to reopen the investigation and check up the statement made nearly 15 years ago by Chopra and Mukerji (*loc. cit*). Interest was further focussed on the question when several samples of Indian Ipecac roots were forwarded to this laboratory for chemical estimation of their alkaloid contents by Mr S. N. Bal of the Indian Museum. The analytical results obtained by employing both the recent B. P. and U. S. P. methods with 4 different samples of Ipecac roots received through the courtesy of Mr S. N. Bal is given above in a tabular form.

COMPLETE ANALYSIS OF DIFFERENT PROPORTIONS OF ALKALOIDS AND ASH CONTENTS OF IPECAC ROOTS

	Total alkaloids		Emetine† (Non-phenolic alkaloid)	Cephaeline	Psychotrine	Ash %‡	Acid-insoluble ash, %‡
	By B.P. Method*	By U.S.P. Method*					
Ipecac No. I (1st year old)	1·458	1·426	1·185	0·228	0·026	2·89	0·06
Ipecac No. II (2nd year old)	1·704	1·704	1·212	0·502	0·079	2·00	0·08
Ipecac No. III (3rd year old)	2·330	2·245	1·404	0·864	0·064	2·25	0·05
Ipecac No. IV (4th year old)	2·143	2·125	1·212	0·908	0·061	1·68	0·044

* B.P. (1932) determines the total alkaloids as well as emetine (non-phenolic alkaloid) while U.S.P. XII (1942) determines only the total ether-soluble alkaloids, eliminating the less well known alkaloidal fractions such as cephaeline, psychotrine, etc.

† B.P. limit—Total alkaloids 2% of which 55% emetine (non-phenolic alkaloid).
U.S.P. limit- 2% of ether-soluble alkaloids.

‡ B.P. limit for 'ash content'—not more than 5%.
B.P. limit for 'acid-insoluble ash content'—not more than 2%.

It would be seen that judged from every point of view either with regard to the total ether-soluble alkaloids or with regard to the total alkaloids and the emetine contents, the Indian Ipecac root (3 to 4-year-old samples) agrees with the standard specifications laid down both in the B. P. and in the U. S. P. The 'ash content' and the 'acid insoluble ash content' also are within the B. P. limits.

Bal[2] has already published the pharmacognostic characters of the Indian Ipecac root and has concluded that the roots of 3 to 4 year old plants are the most suitable for pharmaceutical purposes. This conclusion is confirmed by the detailed chemical assay undertaken in this laboratory in collaboration with the Botanical Survey of India.

In view of the above, a conclusion can be drawn that given the proper conditions of cultivation and collection (3 to 4 year old plants), the Indian Ipecac roots would agree in almost all respects with the most recent standards laid down both in the B.P. and U.S.P. Cultivation of Ipecacuanha has been a success in the rubber plantations in the Federated Malay States. Its importance in medicine, particularly as a specific treatment for acute amoebic dysentery, is too well known to need further emphasis. Effort made for its cultivation at the Cinchona Plantations at Mungpoo have not been very encouraging so far. More intensive attention in this direction is called for, particularly in view of the encouraging results obtained from the chemical investigation of the 3 to 4 year old plants grown at Mungpoo.

R. C. GUHA
B. MUKERJI

Biochemical Standardisation Laboratory,
Government of India,
110, Chittaranjan Avenue,
Calcutta, 10-8-1945.

[1] Chopra and Mukerji, *Ind. Med. Gaz.*, *67*, 43, 1932.
[2] Bal and Datta, SCIENCE AND CULTURE, *10*, 448, 1945.

THE INDIAN BULL-FROG (*RANA TIGERINA* DAUD.)—A MENACE TO FISHERY

VERY recently it has been brought to my notice (*in literis*, 1-9-1945) by Mr B. N. Das Gupta, Superintendent of Fisheries, Eastern Circle, Dacca, that

one of his District Fishery Officers informed him of *Rana tigerina* Daud., creating havoc in shallow tanks at Kaunia Fish farm, Bengal, by devouring carp-fries of ½ to 1½ inches in size. The percentages of mortality of fries attributed to frogs alone are said to be great. Mr Das Gupta, in course of his inspection of this area, was an eye-witness to a bull-frog engulfing half of a carp-fry measuring about 2 inches in length. In this connexion I recall a similar incident occurring at some ponds at Dacca, of which I heard last year from Mr S. N. Basu, Superintendent of Fish Farm, Bengal. It is well known that *R. tigerina* is extremely predacious and cannibalistic too[1-5], but among its much-varied menu the fish was not tabled. As I am not aware of any written record of *R. tigerina* eating up carp-fries and thus causing damages to nursery tanks in fisheries, I think it worth while to add another variety to its already too large a bill of fare.

Two other species of frogs, *viz., R. cyanophlyctis* and *R. hexadactyla* are said to eat frogs and tadpoles. The latter is commonly a south Indian frog, but its occurrences in Bengal are rare and sporadic[6, 7], while the skipper frog *R. cyanophlyctis* is a constant resident of all tanks, ponds, etc., throughout all parts of India especially during monsoon months. From their menu it cannot be said with any degree of certainty that they are as rapacious as the bullfrog. Nonetheless, it is worth investigating if these species (besides, of course, *R. tigerina*) indulge in eating carp-fries.

However, the recent incident, noted above, should certainly arouse great interest in considering *R. tigerina* as a menace to fish nurseries.

J. L. BHADURI

Department of Zoology,
University of Calcutta
35, Ballygunge Circular Road,
Calcutta, 15-8-1945.

[1] Charrington, H. N., *J. Bom. Nat. Hist. Soc., 41*, 688, 1940.
[2] Deshpande, D. S., *Proc. Ind. Sci. Congr.*, Calcutta, *22*, 321, 1935.
[3] Dharmakumarsinghji, R. K., *J. Bom. Nat. Hist. Soc., 42*, 200, 1940.
[4] Mahendra, B. C., *ibid., 33*, 724, 1929.
[5] McCann, C., *ibid., 36*, 152, 1932.
[6] Bhaduri, J. L., *J. Bom. Nat. Hist. Soc., 36*, 514, 1933.
[7] Bhaduri, J. L., *ibid., 44*, 668, 1940.

HIGH FREQUENCY DISCHARGE THROUGH OXYGEN

DURING the course of an investigation of the spectrum of oxygen excited by h.f. oscillations produced by a Telefunken valve (220 volts, 0.15 amps.), peculiar visual observations, regarding colour and the physical form of the glow of oxygen have been made. To start with at comparatively high pressures of the order of 1cm of Hg the glow first appears faintly and remains confined only to the electrodes as usual. On reducing the pressure the glow first extends within the electrodes, bulging out in the centre and then conically beyond the electrodes and gains in intensity. The colour of the glow is greenish yellow and there are observed, as is expected theoretically, two maxima of intensity, which correspond to capacity readings 88 and 55 ($\lambda\lambda$295 and 200 metres) respectively (with electrodes about 6 cms. apart).

Now when the discharge tube is run for about 72 hours or so, the glow of oxygen develops both in colour and in form. The greenish yellow glow changes over to a more intense golden yellow glow, extending more and more beyond the electrodes. It finally splits up into three intense parts, one in the centre of the electrodes and the other two, much beyond the two electrodes, with a smoky diffuse glow smeared over throughout and extending much beyond the two intense parts. After an hour or so more, the glow becomes completely extinguished.* The whole development takes place in about 50 to 60 hours at the most.

It should be noted here that along with the development in colour and form of the glow there occurs an equally, or even more, remarkable change in the intensity maxima. At first the higher capacity reading, 88 (λ295, metres) corresponding to one of the maxima of intensity shifts to lower and lower values, whereas the other capacity reading, 55, (λ200 metres) corresponding to the other maxima of intensity remains unchanged ; finally, both the maxima of intensity coincide at the lower capacity reading, 55, (λ200 metres) and after some time more the glow disappears altogether.

This periodic disappearance of the oxygen glow was at first suspected to be due to a possible leak in the discharge tub . Repeated observations, however, have ruled out completely the possibility of there being any leak in the discharge tube. It is further observed that once the glow has disappeared in this way it can be brought back only by admitting a little more of oxygen in the discharge tube. This reappearance of the glow on admitting a little more of oxygen indicates clearly that the periodic disappearance of the glow of oxygen is caused by a decrease in pressure of the oxygen gas inside the discharge tube which means that the oxygen in the discharge tube is used up approximately periodically under the h.f. discharge.

* The observation may at first sight be taken for the "clean up" effect of oxygen described by R. W. Wood (*Phys. Rev., 35*, 680, 1930). But it is clearly to be noted that it is different from that in the sense that oxygen reappears in Wood's tube on heating or standing the tube for some time, whereas in the present case oxygen does not reappear by any of these or other devices; in order to get the oxygen glow again fresh oxygen has to be admitted in the discharge tube.

Our thanks are due to Prof. Dr R. K. Asundi, under whose guidance the work has been done.

LALJI LAL

Department of Physics,
Benares Hindu University,
Benares, 27-8-1945.

OBSERVATIONS ON THE EXTENT OF POLLUTION AND GENERAL QUALITY OF MARKET GARDEN CROPS GROWN ON SEWAGE

DURING recent years, considerable amount of attention has been devoted to the study of the quality of sewage grown market garden crops as affected by pathogenic and other putrefactive organisms present in sewage. A close study of the very large volume of literature that has accumulated on the subject would show that rather conflicting opinions are held by different investigators[1-8] in regard to the suitability of sewage grown vegetables for human consumption. In most cases the scientific information is neither quantitative nor conclusive. Apart from the above, there is considerable amount of sentimental objection to the use of sewage grown vegetables in many parts of the World. At the same time, it is very difficult to collect direct evidence bearing on the effects of prolonged use of such crops by men. Animal experiments are not likely to throw any fresh light on the subject chiefly because of the fact that they possess much more powerful digestive systems and are usually resistant to the lower grade putrefactive organisms. As it is now definitely established, that the use of polluted water is injurious to public health, it has been considered desirable to approach the subject from that angle by determining the distribution and persistence of putrefactive organisms on sewage farm soils, as also the intensity and persistence of such organisms on sewage grown vegetables. The following is a summary of our recent findings in this direction.

Samples of sewage farm soils under crops (such as amaranthus, radish, lettuce, tomato and brinjal) taken from different depths (0″—12″), at varying periods, after sewage irrigation (24 hrs.—72 hrs.), have invariably shown the presence of considerable numbers of *B. Coli* derived from the sewage, more especially in the surface layers. Successive washings of the vegetables have also shown that the organisms persist more on vegetables such as the amaranthus, lettuce and radish, than on crops like brinjal and tomato.

With a view to ascertaining whether the bacterial forms penetrate inside the crops, pot trials were carried out with tomatoes, treating the sewage in different ways (chemically and biologically). Comparative studies with other manures (farmyard manure, hongay cake, cow dung and horse dung) and fertilizers (ammonium sulphate and superphosphate) were also conducted. The ripe fruits were plucked at intervals during the fruiting period, washed well with water, and finally with alcohol and the pulp scooped out, under sterile conditions, on nutrient agar and McConkey lactose agar. The results showed that living bacteria were absent within clean whole fruits. When the fruits were, however, even slightly injured, or cracked (as is often noticed in the case of tomatoes), they were found very heavily infected in the same way as the surface or the exterior of the fruits.

Observations on other sewage grown crops have consistently shown that they all carry superficial infection (presumably due to splashing of sewage and the blowing of dust infected with the organisms), though they are sterile within. It is not always easy to wash off or to kill out the infection by cooking. It is here that we have the main risk in using sewage grown market garden crops, especially in the raw state. In the case of vegetables like lettuce, cabbage and cauliflower, there is also evidence of the water soluble matter of the sewage soaking through the exposed parts. Such crops usually perish more quickly than those grown on water.

Apart from being carriers of polluting organisms, sewage grown crops may also have absorbed quite a considerable amount of the water soluble matter of sewage, including the bacterial metabolices which would be present in solution. These would be definitely injurious if they are present in drinking water. It is difficult however to say as to how far these products are oxidized or otherwise transformed in the plant system. There is however a lively possibility that a certain quantity of the sewage constituents would always be present in the succulent types of vegetables which continuously absorb water soluble nutrients from the soil.

The sewage grown crops, especially soft and juicy vegetables cannot, therefore, be recommended with safety as article of human food. There would undoubtedly be some who develop the necessary immunity, but it is reasonable to expect that a considerable section will be liable to suffer from some form or other of intestinal disorder consequent on prolonged consumption of sewage grown crops.

Certain grain crops such as ragi, may be raised on sewage. The infection adhering to the grains may normally be expected to die out after prolonged drying and storage. The lingering spores would be fairly harmless. Plants like the papaya and plantain may also be grown, since they grow well above the

ground level and do not, therefore, come into direct contact with wet sewage.

Sewage has indeed considerable possibilities for growing grasses and other fodder crops. The farm animals are usually immune to the putrefactive organisms from sewage. Sugarcane may also be raised on sewage, especially when the crop is used for making *gur* or white sugar, because the boiling and the other processes will kill out all the polluting organisms.

Sewage farming presents certain unique features as distinct from the common agricultural practice. In the latter case, the manure is applied well before the crop goes into the soil. The manure undergoes oxidation and the putrefactive and pathogenic organisms, if any be present, are practically killed out before the plant actually begins its life. There is no further application of any organic manure during the life time of the crop, so that the latter is comparatively free from undesirable forms of life and their metabolic products. On the other hand, sewage farming involves continued application of a fluid which, though rich in fertilizing ingredients, also carries a good deal of undesirable forms of life. Ordinarily, sewage farms have no facilities for either diluting the sewage or for using water for a change whenever considered necessary. The sewage is the only source of water for the plants, so much so if any crop has to be raised, it has got to be on the sewage alone. This naturally raises a number of technical problems of which only one has been referred to in the present contribution. There are also a number of other problems of practical importance some of which have been solved fairly satisfactorily, while others are still awaiting solution.

S. C. Pillai
R. Rajagopalan
V. Subrahmanyan

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 3-9-1945.

[1] Heitz, *Wasser U. Abwasser.*, *30*, 224, 1932.
[2] Kohlschutter, H., *Gesundh Ing.*, *59*, 754, 1936.
[3] Lander, P. E., *Agri. Res. Inst. Pusa Bull.*, *16*, 725, 1934.
[4] Marchoux, *Rev. Hyg.*, *45*, 300, 1923.
[5] Mitchell, G. A., *Eng. News Record*, *119*, 63, 1937.
[6] Stableforth, A. W., *Vet. Rec. 14*, 125, 1934.
[7] Wilson, H., Inst. Sewage Purification (South African Branch), 1944.
[8] Zielstorff, W. and Keller, A., *Z. Pflanzenernahr Dungung U. Bodenk*, *B 11*, 215, 1932.

EFFECT OF VARYING WATER LEVELS ON GROWTH OF RICE IN RELATION TO CARBOHYDRATE METABOLISM OF THE LEAVES

Sen[1] on growth studies of four varieties of rice under varying conditions of water has reported that water standing above the soil suppresses tillering and consequently total yield is much reduced ; height of the plant increases as water level rises. Ghosh[2] on growth studies of rice under varying conditions of water in relation to nitrogen absorption has observed that the slight differences in nitrogen absorption are not sufficient to explain the large differences in growth and final yield as noted in his experiments. The present note deals with the effect of varying water levels on growth of a late variety of aman paddy, "Bhasamanik", in relation to carbohydrate metabolism of the leaves.

The effect of varying water levels on rice after transplantation was studied in plants grown in pots in cemented tanks under 3 levels of watering namely, no water in tank, pots watered to maintain a certain condition of soil moisture (A), water in tank upto the level of soil in pots (B), and water in tank upto one foot above the level of soil in pots (C). The data for growth analysis have shown that increasing water level resulted in diminished meristematic activity as evidenced by the low production of tillers. The reduction in number of tillers is associated with the accumulation of sugar in the leaves ; maximum sugar content being noticed in the highest level of water supply where tillering is much suppressed. Thus an inverse relation between tillering and sugar content as an effect of water supply is evident. The results are given in the accompaying tables.

TABLE I

AVERAGE NUMBER OF TILLERS PER PLANT

Weeks after transplantation

Treatment	II	III	IV	V	VI	VII	VIII	IX	X
A	2·0	3·5	5·3	7·1	8·3	9·0	9·1	9·0	9·0
B	1·8	2·7	3·6	4·9	5·2	5·1	5·1	4·8	4·9
C	1·4	2·1	1·8	1·9	2·4	2·6	2·8	2·6	2·7

Similar relation between tillering and sugar content has also been shown by Gregory and Baptiste[3] in their work on carbohydrate metabolism in relation to nutrient deficiency and to age in leaves in barley. In N-deficiency the accumulation of sugar takes place and this has been found to be related to low meristematic activity as indicated by the reduced number of tillers, while K-deficiency shows increased tiller number and low sugar content. It has been suggested that N-deficiency checks protein synthesis leading to the reduction in tillering and

thus explains that sugar not being utilized accumulates in the leaves. While in K-deficiency considerable protein synthesis and maximum number of tillers explain the low level of sugar. In treatments with water it appears that water standing above the soil inhibits the laying down of tiller meristems in the axils of leaves which lie submerged in water. Due to this low meristematic activity demand for sugar decreases resulting in an increased sugar content in the successive leaves. In treatment where soil is free from water-logging greatest number of tillers were produced and the maximum utilization of sugar was noticed. That the synthesis of sugar is not limiting the production of tillers in treatments with standing water is evident since sugar is already in excess in the leaves in treatments with water.

TABLE II

TOTAL SUGAR AS PERCENTAGE OF DRY WEIGHT

Leaf No.	Treatment	8 A.M.	5 P.M.
7	A	21·808	10·620
	B	23·841	22·235
	C	33·917	37·134
8	A	16·138	17·526
	B	28·904	24·525
	C	34·242	38·314
9	A	11·905	17·011
	B	23·877	26·746
	C	37·083	33·442
10	A	13·925	16·429
	B	23·188	20·866
	C	23·534	23·593
11	A	13·676	12·082
	B	21·252	13·575
	C	18·188	28·382

Full details of the experiment will be published elsewhere. The work was carried out in the Botanical Laboratory, Calcutta University under the guidance of Prof. S. P. Agharkar, Ghose Professor and Head of the Department of Botany, Calcutta University for which my grateful thanks are due to him.

B. N. GHOSH

Central Agricultural Research Station,
Dacca, Bengal,
5-9-1945.

[1] Sen, P. K., *Ind. Jour. Agri. Sc.*, 7, 1, 89, 1937.
[2] Ghosh, B. N., M.Sc. Thesis, Calcutta University, 1936.
[3] Gregory, F. G. and Baptiste, E. C. D., *Annals of Botany*, *50*, 579, 1936.

Indian Science News Association

PROCEEDINGS OF THE TENTH ANNUAL MEETING

THE Tenth Annual General Meeting of the Indian Science News Association was held on September 12, 1945 at 5-30 P.M. in the hall of the Applied Chemistry Department at the University College of Science, Calcutta.

In the absence of Sir U. N. Brahmachari, President of the Association, Prof. P. N. Ghosh, Vice-President was in the Chair.

The proceedings of the last annual meeting were read and confirmed.

On behalf of the Secretaries Prof. P. Ray submitted the following report of the working of the Association and the audited accounts for the year 1st July, 1944 to 30th June, 1945.

Annual Report

The Council of the Indian Science News have much pleasure in submitting this, the Tenth Annual Report and the Statement of Accounts for the period July 1, 1944 to June 30, 1945.

Membership

During the last year *i.e.*, 1944-45, 12 new members joined the Indian Science News Asociation as compared to 14 in the previous year.

The number of life members at the close of the year under review was 91 compared to 89 on the corresponding date last year showing an increase of 2.

Science and Culture

The total number of copies of SCIENCE AND CULTURE despatched in June 1945, the last month of the period, was 1385 as compared with 1127 in the same month of 1944. The number of subscribers in June 1945 (including members of the Association) was 1157, which represents an increase of 203 since June, 1944. The actual number of new subscribers enrolled was however 251.

In the absence of high quality paper, we had to print the journal on inferior material. Since last August we have been able to procure a superior quality of paper and we expect to provide a still better stuff from the next issue.

During the year 1944-45 authoritative articles from the pens of specialists were published and the high standard of the journal was maintained inspite of the abnormal situation arising out of the war.

Exchange Journals

The total number of copies of the journal sent out every month in exchange and for review was 73. We received in exchange 38 Indian and 17 foreign journals. We also received journals of learned societies and publications of Government Scientific Departments. Several Calcutta newspapers, *viz.*, *The Statesman*, the *Hindusthan Standard*, the *Amrita Bazar Patrika*, *Nationalist*, and *Jugantar* supply their daily issues in exchange. The well known Madras daily the *Hindu*, has also been added to the list. We send the journal regularly to several Societies and Institutions on request.

Adair, Dutt Research Fund

We are glad to annouce that the well known firm of Messrs. Adair, Dutt & Co. Ltd., dealing with scientific instruments, has placed at our disposal a further sum of Rs. 8,200/- for award as research scholarships. The following scholars, at present engaged on research work, are paid from this fund.

(1) Mr. Satyendra Nath Ghosh Upper Atmosphere.
(2) Mrs. Amina Rahman .. Biochemistry.
(3) Mr. Jyotirmay Bhattacharji D. D. T.
(4) Mr. Amal Chandra Ghosh .. Cyclotron.
(5) Mr. P. Nandi Microbiology.

(*For Statement of Accounts, see last page*)

Grants

We are grateful to the authorities of the University of Calcutta, the Bengal Chemical and Pharmaceutical Works, Ltd., and the Indian Association for the Cultivation of Science for renewing their annual grants. The amounts of these grants are as follows:

Calcutta University ...	...	Rs. 500
Bengal Chemical & Pharmaceutical Works, Ltd. ...	...	,, 500
Indian Association for the Cultivation of Science ...	...	,, 100

During the year the Association was fortunate enough to receive the following donations, for which we express our sincerest thanks to the donors.

Mr R. P. Shaha ...	...	Rs. 2,000

Rockefeller Foundation Grant through National Institute of Sciences of India	..	,,	750

Our thanks are further due to the Authorities of the Calcutta University for accommodating the office of SCIENCE AND CULTURE in the University Science College building.

ACKNOWLEDGEMENT

We owe a debt of gratitude to our subscribers and well-wishers who have helped us in securing new subscribers. We would in this conection mention the name Mr S. Bose, Meteorologist, Bangalore, who has supplied us with a fairly large stock of back numbers of SCIENCE AND CULTURE, free of cost.

CONCLUSION

This war has been largely fought by scientists working indefatigably in the laboratories, factories, universities and in the field, behind the fighting services. The way in which they have solved war time problems of food, clothing, housing, medicine and public health is a pointer to the immense responsibilities which rest on the scientists in the new era of reconstruction to follow the war. Forces of reaction menacing peaceful existence have been won for the time being and the war is won, but mankind is yet to score a victory over the peace-time axis combination of poverty, disease and malnutrition, and to this one may as well add blind unreason and savage prejudice, threatening all attempts at the establishment of a better social order. Mobilization of science in all spheres of human activity can alone help us to win a total and indivisible peace just as a total war. We are confident that our journal, in co-operation with the scientists of all parts of India, will be called upon to pay a more important and vital role in the years ahead when problems of reconstruction will come up for solution before the nation.

(For Statement of account see next page)

The following persons were unanimously elected officers and members of the council for the year 1st July, 1945 to 30th June, 1946:

President.—Sir U. N. Brahmachari.

Vice-Presidents.—Dr S. C. Law, Dr Baini Prashad, Prof. M. N. Saha, Prof. D. N. Wadia, Sir S. S. Bhatnagar, Prof. P. N. Ghosh, Prof. S. K. Mitra.

Treasurer.—Prof. P. C. Mitter.

Secretaries.—Prof. P. Ray and Dr D. M. Bose.

Members.—Prof. S. P. Agharkar, Dr B. Ahmad, Mr H. P. Bhaumik, Dr B. C. Guha, Dr K. Biswas, Dr W. D. West, Col. Sir R. N. Chopra, Dr M. S. Krishnan, Sir J. C. Ghosh, Dr D. S. Kothari, Mr B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Prof. J. N. Mukherjee, Dr John Matthai, Mr M. M. Sur, Dr S. L. Hora and Dr A. C. Ukil.

The Editorial Board of SCIENCE AND CULTURE for the next year was constituted with Sir J. C. Ghosh, Prof. M. N. Saha, Dr A. C. Ukil and two Secretaries as ex-officio members.

The President then delivered his address of welcome and laid stress on the great service which SCIENCE AND CULTURE rendered to the cause of spreading scientific knowledge among the Indian people, during the difficult years of the war.

Mr G. L. Mehta, the Guest in Chief, in course of his address, remarked:

"Our age is one in which power is being substituted for older and better ideals and this is happening in science as in other spheres.

In the modern world the power of science had become great and it was science as an instrument of power rather than science as a method of arriving at truth that appealed to people. The ordinary man has been thrilled and awed, bewildered and is now even frightened of science, especially after the invention and use of the atomic bomb which has been a shock to moral conscience.

The West is drunk with power and utilizes science for domination and exploitation of weaker peoples of the world. Even during this war, there have been remarkable and epoch-making scientific discoveries and inventions like radar, penicillin and plastics. But Western civilization has also given us the blessings of air-warfare, poison gas and torpedoing, which are equally the fruits of science. In the next war, it is evident that the side which secures the first blow will win.

The atomic bomb has been justified on the ground that the end justifies the means. But a good end if it cannot be achieved without wholesale and indiscriminate slaughter, is not worth achieving. It is certain that the experience gained in war of using not only the results of scientific research and inventiveness but the scientific approach to wider problems is indispensable to the solution of the problems of peace."

Concluding Mr Mehta observed: "We must have a right conception of the ends of life because science can only provide us with the means. Man is becoming so strong that unless he becomes wise, he will perish. The West must imbibe some of the wisdom for which it despises the East."

The Association had the pleasure of the presence of Col. S. L. Bhatia, one of the members of the Indian Scientific Mission that visited the U. K., U. S. A. and Canada. Col. Bhatia appreciated Mr Mehta's remarks and made a few brief and candid observations regarding the social aspect of scientific research and advancement.

Prof. S. K. Mitra proposed a vote thanks to the Guest in Chief.

INDIAN SCIENCE NEWS ASSOCIATION

(REGISTERED UNDER ACT XXI OF 1860)

Receipts and Payments Account for the year ended 30th June, 1945.

RECEIPTS	Rs. As. P.	Rs. As. P.	PAYMENTS	Rs. As. P.	Rs. As. P.
To *Opening Balances on 1-7-44* :—			By Establishment	...	4,755 2 0
(*a*) At Bengal Central Bank Ltd. in Savings A/c. ...	1,143 8 3		,, Journal Printing	...	5,270 13 0
(re : SCIENCE & CULTURE A/c.)			,, Paper	...	2,926 4 9
(*b*) At Bengal Central Bank Ltd. in Current A/c. ...	6,353 3 3		,, Postage & Receipt Stamp ...	...	677 8 0
(*c*) With Treasurer ...	67 9 6		,, Conveyance	...	221 4 3
		7,564 5 0	,, Telephone	...	251 1 0
,, Grant	...	1,100 0 0	,, Sir P. C. Ray Biography A/c.	...	300 0 0
,, Donation	...	3,250 0 0	,, Miscellaneous	...	360 10 9
,, Donation re : Adair Dutt Research Fund	...	8,200 0 0	,, Audit Fee (1943-44) ..	...	40 0 0
,, Life-Membership Fee	.	325 4 0	,, Stationery & Printing ...	...	206 3 0
,, Ordinary Membership Fee ...	..	441 2 0	,, Bank Charges	...	83 15 9
,, Subscription	...	4,615 11 6	,, Binding Charges	...	47 0 0
,, Advertisement	...	6,344 4 0	,, Adair Dutt Research Fund ...	...	8,200 0 0
,, Reprint	...	559 0 0	,, Investment (3½% G. P. Notes of 1900—Nominal Rs. 5,000/- held by the Bengal Central Bank Ltd. in Safe Custody)	...	5,025 9 6
,, Miscellaneous	...	759 9 0	,, *Closing Balances on 30-6-45* :—		
,, *Interest* :—			(*a*) At Bengal Central Bank Ltd. in Savings A/c. (re : SCIENCE & CULTURE)	1,748 2 9	
On 3½% G. P. Notes ...	62 14 0		(*b*) At Bengal Central Bank Ltd. in Current A/c. ...	3,059 4 6	
On Bank Accounts ...	40 1 3		(*c*) With Treasurer ...	89 3 6	
		102 15 3			4,896 10 9
	Rs.	33,262 2 9		Rs.	33,262 2 9

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of INDIAN SCIENCE NEWS ASSOCIATION (Registered under Act XXI of 1860) for the year ended 30th June, 1945, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the said account is correctly stated in accordance with the books of accounts of the Association.

6, Old Post Office Street,
Calcutta, the 11th August, 1945.

Sd. S. K. MITRA,
Sd. P. Ray,
Honorary Secretaries,

Sd. A. K. GHOSH,
Government Diplomaed Accountant,
Register Accountant,
Auditor.

Sd. P. C. MITTER,
Hon. Treasurer.

ADAIR, DUTT RESEARCH FUND

Receipts and Payments Account for the year ended 30th June, 1945.

RECEIPTS	Rs. As. P.	Rs. As. P.	PAYMENTS	Rs. As. P.	Rs. As. P.
To *Opening Balances on 1-7-44* :—			By Stipend	...	3,125 0 0
(*a*) At Bengal Central Bank Ltd. in Savings A/c. ...	5,536 2 1		,, Establishment	...	200 0 0
(*b*) With Treasurer ...	28 10 6		,, Accountancy Charges ...	...	10 0 0
		5,564 12 7	,, Contingency	...	2 11 6
,, Indian Science News Association	...	8,200 0 0	,, Bank Charges	...	0 5 0
,, Bank Interest ...	...	98 7 6	,, *Closing Balances on 30-6-45* :—		
			(*a*) At Bengal Central Bank Ltd. in Savings A/c. ...	10,359 4 7	
			(*b*) With Treasurer ..	165 15 0	
					10,525 3 7
	Rs.	13,863 4 1		Rs.	13,863 4 1

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of ADAIR, DUTT RESEARCH FUND for the year ended 30th June, 1945, with the books and vouchers and have obtained all the information and explanations I have required I certify that the said account is correctly stated in accordance with the books of accounts of the Fund.

6, Old Post Office Street,
Calcutta, the 11th August, 1945.

P. RAY,
Secretary,
G. BHATTACHARYA,
Treasurer,
Adair, Dutt Research Fund.

Sd. A. K. GHOSH,
Government Diplomaed Accountant
Registered Accountant,
Auditor.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. XI. NOVEMBER, 1945 No. 5

WHAT NATIONALISTIC INDIA STANDS FOR : MANIFESTO BY THE CONGRESS HIGH COMMAND

THE HIGHLIGHTS ARE:

(1) The Congress stands for equal rights and opportunities for every citizen of India.

(2) It stands for the unity of all communities and religious groups and for tolerance and good-will between them.

(3) It stands for full opportunities for people as a whole to grow and develop according to their own wishes and genius.

(4) It stands for freedom of each group and territorial area to develop its own life and culture within the larger framework.

(5) It stands for the re-grouping of provinces on a linguistic and cultural basis.

(6) It stands for rights of all those suffering from social tyranny and injustice and for the removal for them of all barriers to equality.

(7) The Congress envisages a free democratic state with fundamental rights and liberties of all its citizens guaranteed in its constitution.

(8) The Congress stands for a federal constitution with a great deal of autonomy for its constituent units.

(9) The Congress will tackle the most urgent and vital problem of India, namely, the removal of the curse of poverty and raising of the standard of life of the masses.

(10) The Congress stands for modernisation of industry and agriculture and social control of all sources of wealth, methods of production and distribution so that India may grow into a co-operative commonwealth.

(11) In international affairs the Congress stands for the establishment of a federation of free nations, and

(12) The Congress will champion the cause of the freedom of all subject nations and elimination of imperialism everywhere.

Science and Culture has been advocating a national programme on the above lines, for the last ten years and it is gratifying that the Congress High Command has now made it the basis of their appeal to the country for the forthcoming elections.

THE LOGIC OF THE ATOMIC BOMB

IT is said that Louis XIV, the grand monarch who ruled France during the seventeenth century, caused the words *"Logice Regum", i.e.*, Logic of Kings to be inscribed on his guns. It is well known to students of history that flushed with power, Louis tried to apply this logic to the countries surrounding France, *viz.*, the Netherlands, Germany, Spain and Italy. For a time, the logic of guns worked all right, and in favour of France. But when the rulers of these countries combined and began to retaliate on Louis with the same logic, a bitter struggle ensued, but ultimately the grand monarch's projects collapsed, and he had to suffer defeat, humiliation and extreme bitterness of disappointment during the closing years of his life.

History has now repeated itself. Hitler who tried to repeat the exploits of the grand monarch by the use of bombing aeroplanes, tanks and guns as the King's or should we say the *Dictator's Logic* has been defeated and destroyed by the use of his own logic, and has dragged down in his fall, the great country of Germany to a depth of degradation unknown in her history. But Hitler had hopes that Germany's scientists would be able to devise a weapon far more terrible in its effects than anything hitherto known and he would be enabled to apply this new logic, *i.e.*, the logic of Atomic Bombs, on his adversaries in a last hour attempt to avoid encirclement, and destruction. But his scientists probably failed him by a few months, and it was reserved for his adversaries probably to some extent aided by captured German scientists, to bring this weapon to perfection, and apply this logic on Japan, and compel that proud country which has never known subjection to her knees.

A story of the discoveries in physics which led to the invention of the Atomic Bomb has been given in the August number of SCIENCE AND CULTURE, and Great Britain's part in the work is recounted in a publication by H. M.'s Government which is reproduced with a running commentary in our next article. The part played by the chief actor, *viz.*, the U. S. A. and of Canada is not yet known with precision, but can be guessed. The potentiality of the great discovery of Uranium Fission by Otto Hahn in 1939 had been almost immediately grasped by the leading scientists of all nations, but probably if things were left to run their usual course, the actual invention of the atomic bomb would have taken decades, and it was quite possible it might never have come at all. But as our next article shows the exigencies of the war compelled the leaders of allied nations to mobilize their best scientists and technicians in an all-out effort and place at their disposal unlimited funds for carrying out the necessary experiments on a scale undreamt of before. And thus was evolved the great weapon which cut short the war by at least two years.*

But there is another side of this fascinating story of the power of co-operative scientific effort, which is far less pleasing! It is the question of the probable use of the logic of the Atomic Bomb in future conflicts on the course of human history!

As our London contemporary *Nature* (August 11, 1945) puts it:

"Great Britain, the United States of America, and Canada hold in their hands a weapon with which they can dominate the world."

Our contemporary either fails to note, or refrains from saying so from a sense of delicacy that these countries dominate three-fourths of the land surface of the globe leaving only one-fourth to Soviet Russia.

The present position is that the U. S. A. being already in the possession of the secret technical knowledge of the atomic bomb, and having all industrial plants ready is in a position to produce a fairly good number of far more powerful atomic bombs within a short time, and has shown herself extremely reluctant to share this secret with any other power. This has given rise to an outburst, which appears to us largely hypocritical, of moral indignation on the part of some powers which are not possessed of the secret, though they have not in the past, shown any scruples in using Louis XIV's logic on their own subject races.

It is doubtful whether any other power is just now in a position to emulate the U. S. A. in the production of the atom bomb. But this position of inferiority cannot continue for a long time, and provided a State is allowed to retain its sovereignty, it can undertake making of 'Atomic Bombs', and can probably produce them in sufficient number within a short time, as Professor Oliphant, the Australian physicist who has taken part in the evolution of the atomic bomb pointed out in a press statement: "There is not much of secret in the Atomic Bomb. The fundamental physical processes

* Compare with this the story of the invention of the internal combustion engine. It may not be known to the general public that it was the Dutch physicist Huygens who made the first suggestion of making an internal combustion engine in 1660 by a sereis of well timed explosions of gun powder, but it took two hundred years before the first crude internal combustion engine could be produced for the market. The discovery of Uranium Fission took only four years to bear fruit in the form of the most terrible engine of war! Thanks to State aid and co-operative work of a team of scientists, technicians and industrialists, centuries have been compressed into as many years.

are well known to scientists of all countries, and even those countries who do not possess it now can have it within a short time say a few months or at most two years if they harness their scientists for team work as the U. S. A. had done, and are prepared to spare the necessary power and equipment." Professor Oliphant thinks that Atom Bombs of 50 times more destructive power than those hurled on Hiroshima can be prepared and a few of these can destroy all the great cities of a country.

The effect of a third world war in which the atomic bomb may be fully and freely used, on human civilization, nay, on the very existence of *homo sapiens* on this planet, will be so frightful that blood congeals in our vein to think of such a catastrophe! Those who were responsible for the making of the Atomic Bomb, and using it on the unfortunate residents of Hiroshima and Nagasaki have therefore taken upon themselves a terrible responsibility. But are these men alive to a sense of their responsibility?

We have in vain looked for this in the pronouncements of the political leaders of the victorious nations. Their statements and actions show that they wish to keep the secret to themselves, and squeeze the rest of the world, consisting of doubtful friends, vanquished enemies and downtrodden colonials to the *"Fait Accompli or Status Quo"* by the threat of the Atomic Bomb. The result has been a most unhealthy race for the new weapon, and recently even France has entered the race! What will be the sequel of this race for atomic power!

The statements which the Allied statesmen are making in justification of the use of the Atomic Bomb recalls Dr Nobel's hope expressed on the discovery of the dynamite that this and other explosive would make war so terrible that in future all wars would cease. Perhaps the God of Destruction was laughing in his sleeves when Nobel made this statement, and probably he is no less amused this time over the justification of the use of Atomic Bomb by the war lords, and their satellites on the pseudo humanitarian plea that the threat of atom bombs would make any further war impossible.* The hollowness of such professions is apparent to far-seeing philosophers like Bertrand Russel who in a recent press statement on the Atomic Bomb pointed out that if mankind were ever to have peace, there should be only an One-Power World.† The implications of such a policy is however, too terrible to think of, but who knows if thoughts, and events, as they are progressing, may not be marching towards that direction? But is an One-Power World desirable either from the point of view of the conquerors or the conquered?

World's history has seen something like a One-Power World during the days of the Roman Imperialism (44 B.C. to 470 A.D.). True, there were other great and powerful countries like China, India, and Iran which Imperial Rome was unable to conquer, but all these countries except Iran, were little self-contained worlds in themselves. Within the area round about the Mediterranean sea, the Roman Eagle flew unchallenged for four hundred years over an assembly of ancient and cultured nations like Greeks, Egyptians, Carthagians, Phoenicians, and Mesopotamians whose contribution to civilization had been as great as Rome's and a medley of cultureless Northern Barbarians from whom are descended the modern West European Nations. But under Roman domination, though these countries were relieved of the duty of defending themselves and law and order were fully maintained, the springs of culture of these ancient nations dried up almost completely leaving a conglomeration of hungry, and poverty stricken *amorphous* people, to whom the very existence was a burden. This was the result of loss of political sovereignty. The march of civilization was retarded for nearly 1,500 years it was recreated and resumed by the descendants of northern barbarians. What was the effect on Rome itself? The influx of cheap wealth, from colonial exploitation and accession of irresponsibile power spoilt entirely the ancient virtues which made Rome great and sapped her very vitality. First, as a result of the corruption the big Roman families who had built up the greatness of Rome died out and disappeared, then came rule by foreign-born Romans, and ultimately the original Roman Nation disappeared and was replaced by the Romanised Northern Barbarians. The history of these declining years of Roman Imperialism is not one of progress, and happiness, but of stagnation, decay, famine and pestilence.

If in the near future, we have One-Power World, as appears to be the tendency from the intended use of the logic of the Atomic Bomb, its effect on the rulers would be no less ruinous than on the ruled.

The 'Suppressed Nationalities' of the world whose ranks have now been swollen by the vanquished nations can hardly expect any relief, as long as power remains in the hands of the professional power politicians, as our old Kautilya says

*Curiously enough, Chenghiz Khan Jihankusha (world-conqueror) when he ordered wholesale massacre of the inhabitants of the ancient city of Balkh put forward the same humanitarian plea *viz.*, wholesale massacre of citizens of one city will frighten the rest of the country to quick submission, and thus shorten the war, and avoid unnecessary bloodshed.

† Mind that One-Power World is not the same thing as the plea of One World, put forward by Wendell Wilkie which means a World united by common economic ties; but One-Power World means a world dominated by One Power alone.

"who, amongst those posssesing power is not intoxicated, and does not think he is absolutely right?"

But there is another side of the logic of atomic bomb to which the attention of politicians may be drawn. The story of the production of atomic bomb illustrates, as nothing else does, the tremendous powers which science has placed in the hands of man, for good and for evil. It also shows that if a team of well-chosen scientists be selected for studying a problem in an objective way, and be directed to find out the remedy, and if sufficient funds and power be placed in their hands to execute their plans, they can be trusted to solve problems of reconstruction which baffle the professional politician and centuries of neglect can be compressed into decades. The *'Colonial people'* which include most of Asia and Africa, suffer from extreme poverty, disease and malnutrition, may be it is due to the stupidity and backward ideas of the people themselves, or to the want of initiative, or the policy of exploitation on the part of the rulers. There is no point in spinning out a controversy over these points, for it is crystal clear that if the great lessons of science and technology be applied, as Russia has demonstrated, towards the development of the resources of these exploited countries, they can reach the same level of standard of life as in the countries of Europe, say, Sweden. But this clear issue is being clouded by fogs of controversy in the name of nonessential political points, or is being side-tracked by bogus post-war plans of reconstruction hatched in the secretariats by persons who have little competence and sympathy for such work. But if the rulers of the world really wish to uplift the condition of the common man throughout the world, let them replace the officials in their colonial secretariat by a band of scientists, technicians, and economists for objective planning as Russia got together in her National Planning Commission for the great work of reconstruction after the first World War.

BRITAIN'S PART IN THE EVOLUTION OF THE ATOMIC BOMB

THE Government of Great Britain have just issued a pamphlet entitled "Statements Relating to the Atomic Bomb", (H. M. Stationery Office, York House, Kingsway, London, W. C. 2. Price 4*d*. net.) containing statements by the Prime Minister Mr Attlee and Mr Churchill and a report of the Directorate of Tube Alloys, Department of Scientific and Industrial Research. This is the first and the most important official disclosure of the part played by Great Britain in the evolution of the Atomic Bomb, which, we trust, will be pursued by our readers with absorbing interest. Below we reproduce, with our commentaries in the footnotes, the text of those reports, with the omission of part of the historical survey of scientific developments leading to the perfection of the Atomic Bomb, which already appeared in our journal and elsewhere in considerable detail.

STATEMENT BY MR CHURCHILL ISSUED ON MONDAY, AUGUST 6TH, 1945

By the year 1939[1] it had become widely recognized among scientists of many nations that the release of energy by atomic fission was a possibility. The problems which remained to be solved before this possibility could be turned into practical achievement were, however, manifold and immense, and few scientists would at that time have ventured to predict that an atomic bomb could be ready for use by 1945. Nevertheless, the potentialities of the project were so great that His Majesty's Government thought it right that research should be carried on in spite of the many competing claims on our scientific manpower. At this stage the research was carried out mainly in our Universities, principally, Oxford, Cambridge, London (Imperial College), Liverpool and Birmingham. At the time of the formation of the Coalition Government, responsibility for co-ordinating the work and pressing it forward lay in the Ministry of Aircraft Production, advised by a committee of leading scientists presided over by Sir George Thomson.[2]

At the same time, under the general arrangements then in force for the pooling of scientific information, there was a full interchange of ideas between the scientists carrying out this work in the United Kingdom and those in the United States.

[1] The prospects of harnessing the energy of the atomic nucleus was first rendered possible by the discovery of Uranium Fission in the early part of 1939 by Prof. Otto Hahn, assisted by his pupil H. Strassemann, in the Kaiser Wilhelm Institute, Berlin-Dahlem, as narrated in our article on the Atomic Bomb in the August number of SCIENCE AND CULTURE. It was another German physicist, Flugge who first discussed the possibility of utilizing this process in an article in Naturwissenschaft "Can the Energy of Uranium Fission be utilized for Practical Purposes?" An account of the discovery was given in SCIENCE AND CULTURE, June 1941.

[2] Sir George P. Thomson, F.R.S., professor of physics in the Imperial College of Science and Technology. He is famous for his experiment on Electron Diffraction, for which a Nobel Prize was awarded to him. Son of the famous physicist Sir J. J. Thomson.

Such progress was made that by the summer of 1941 Sir George Thomson's Committee was able to report that, in their view, there was a reasonable chance that an atomic bomb could be produced before the end of the war. At the end of August 1941 Lord Cherwell,[3] whose duty it was to keep me informed on all these and other technical developments, reported the substantial progress which was being made. The general responsibility for the scientific research carried on under the various technical committees lay with the then Lord President of the Council, Sir John Anderson. In these circumstances (having in mind also the effect of ordinary high-explosive which we had recently experienced), I referred the matter on August 30, 1941, to the Chiefs of Staff Committee in the following minute:

> "General Ismay for Chiefs of Staff Committee.
>
> Although personally I am quite content with the existing explosives, I feel we must not stand in the path of improvement, and I therefore think that action should be taken in the sense proposed by Lord Cherwell, and that the Cabinet Minister responsible should be Sir John Anderson.
>
> I shall be glad to know what the Chiefs of Staff Committee think."

The Chiefs of Staff recommended immediate action with the maximum priority.

"Directorate of Tube Alloys"

It was then decided to set up within the Department of Scientific and Industrial Research a special division to direct the work, and Imperial Chemical Industries Limited agreed to release Mr W. A. Akers to take charge of this Directorate, which we called, for purposes of secrecy, the "Directorate of Tube Alloys". After Sir John Anderson had ceased to be Lord President and became Chancellor of the Exchequer, I asked him to continue to supervise this work, for which he has special qualifications. To advise him, there was set up under his chairmanship a Consultative Council composed of the President of the Royal Society, the Chairman of the Scientific Advisory Committee of the Cabinet, the Secretary of the Department of Scientific and Industrial Research and Lord Cherwell. The Minister of Aircraft Production, at that time Lord Brabazon, also served on this Committee. Under the Chairmanship of Mr Akers there was also a Technical Committee on which sat the scientists who were directing the different sections of the work, and some others. This Committee[4] was originally composed of Sir James Chadwick, Professor Peierls, and Drs Halban, Simon and Slade. Later it was joined by Sir Charles Darwin and Professors Cockcroft, Oliphant and Feather. Full use was also made of University and industrial laboratories.

On October 11, 1941, President Roosevelt sent me a letter suggesting that any extended efforts on this important matter might usefully be co-ordinated or even jointly conducted. Accordingly all British and American efforts were joined and a number of British scientists concerned proceeded to the United States. Apart from these contacts, complete secrecy guarded all these activities and no single person was informed whose work was not indispensable to progress.

By the summer of 1942 this expanded programme of research had confirmed with surer and broader foundations the promising forecasts which had been made a year earlier, and the time had come when a decision must be made whether or not to proceed with the construction of large-scale production plants. Meanwhile it had become apparent from the preliminary experiments that these plants would have to be on something like the vast scale described in the American statements which have been published to-day.

Great Britain at this period was fully extended in war production and we could not afford such grave interference with the current munitions programmes on which our warlike operations depended. Moreover, Great Britain was within easy range of German bombers, and the risk of raiders from the sea or air could not be ignored. The United States however, where parallel or similar progress had been made, was free from these dangers. The decision was therefore taken to build the full-scale production plants in America.

In the United States the erection of the immense plants was placed under the responsibility of Mr Stimson, United States Secretary of War, and the American Army Administration, whose wonderful

[3] Lord Cherwell, formerly Professor F. A. Lindemann of the Oxford University. As Paymaster General he was a Member of the War Cabinet.

[4] Sir James Chadwick, F.R.S., Nobel Laureate, professor of physics, University of Liverpool, and discoverer of the "Neutron".

R. Peierls, German refugee, famous worker on theoretical physics. Now professor at Birmingham.

H. Halban, French physicist, and a pupil of Profs. F. and I. Joliot-Curie. After the fall of France, he managed to escape to the U.K. with a large amount of heavy hydrogen which was very useful for the experiments on Atomic Bomb.

H. Simon, F.R.S., German refugee physicist, a pupil of W. Nernst, and a great authority on Low Temperature physics. Now professor at Oxford.

H. Slade, Physical chemist.

Sir Charles Darwin, F.R.S., and famous theoretical physicist, now Director of the National Physical Laboratory.

J. D. Cockcroft, F.R.S., professor in Nuclear Physics, Cavendish Laboratory, Cambridge, famous for his pioneering work on the transformation of Li^7 by proton beams.

Oliphant, F.R.S., professor of Physics in the University of Birmingham; Australian by birth, and a famous worker on Nuclear Physics.

N. Feather, F.R.S., just elected to professorship of physics, Edinburgh University.

work and marvellous secrecy[5] cannot be sufficiently admired. The main practical effort and virtually the whole of its prodigious cost now fell upon the United States authorities, who were assisted by a number of British scientists. The relationship of the British and American contributions was regulated by discussion between the late President Roosevelt and myself, and a Combined Policy Committee was set up.

The Canadian Government,[6] whose contribution was most valuable, provided both indispensable raw material for the project as a whole and also necessary facilities for the work of one section of the project which has been carried out in Canada by the three Governments in partnership.

The smoothness with which the arrangements for co-operation which were made in 1943 have been carried into effect is a happy augury for our future relations and reflects great credit on all concerned —on the members of the Combined Policy Committee which we set up; on the enthusiasm with which our scientists and technicians gave of their best—particularly Sir James Chadwick who gave up his work at Liverpool to serve as technical adviser to the United Kingdom members of the Policy Committee and spared no effort; and not least, on the generous spirit with which the whole United States organization welcomed our men and made it possible for them to make their contribution.

By God's mercy British and American science outpaced all German efforts. These were on a considerable scale, but far behind. The possession of these powers by the Germans at any time might have altered the result of the war, and profound anxiety was felt by those who were informed.[7] Every effort was made by our intelligence service and by the Royal Air Force to locate in Germany anything resembling the plants which were being created in the United States. In the winter of 1942-1943 most gallant attacks were made in Norway on two occasions by small parties of volunteers from the British Commandos and Norwegian forces, at very heavy loss of life, upon stores of what is called "heavy water", an element in one of the possible processes.[8] The second of these two attacks was completely successful.

The whole burden of execution, including the setting-up of the plants and many technical processes connected therewith in the practical sphere, constitutes one of the greatest triumphs of American—or indeed human—genius of which there is record. Moreover, the decision to make these enormous expenditures upon a project which, however hopefully established by American and British research, remained nevertheless a heartshaking risk, stands to the everlasting honour of President Roosevelt and his advisers.

It is now for Japan to realize in the glare of the first atomic bomb which has smitten her, what the consequences will be of an indefinite continuance of this terrible means of maintaining a rule of law in the world.

This revelation of the secrets of nature, long mercifully withheld from man, should arouse the most solemn reflections in the mind and conscience of every human being capable of comprehension. We must indeed pray that these awful agencies will be made to conduce to peace among the nations, and that instead of wreaking measureless havoc upon the entire globe, they may become a perennial fountain of world prosperity.

[5] 'Nuclear Physics' went underground in the U.S.A. during the war. Authors and journalists were forbidden to mention anything connected with 'Nuclear Physics', and a famous American physicist was warned for mentioning the word 'Cyclotron' in his lecture.

[6] Canada provides almost the whole of the Uranium-ore required for the making of the Atom Bomb.

[7] We have yet to hear the German story. The Germans gave out that they used some Atom Bombs during the Runsted drive in December, 1944. If they had done so, they had not received the perfection attained by the Anglo-Americans. It was evident that Hitler built great hopes on the Atom Bomb.

[8] Heavy hydrogen was probably required for making the ordinary explosive "bombs" for the production of neutrons. Norway, with its cheap electric power, has been the largest manufacturer of heavy hydrogen.

STATEMENT ISSUED BY THE DIRECTORATE OF TUBE ALLOYS (DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH), ON SUNDAY, AUGUST 12, 1945.

SCIENTIFIC PRINCIPLE

Discovery of Fission

Professor O. Hahn and Dr Strassmann in Berlin became interested in this problem at the end of 1938 and, from the particular point of view of their chemical nature, carefully re-examined the new elements. In January, 1939, they published a most important paper in which they reported positive chemical evidence to show that one, at least, of the new isotopes which were believed to be of higher atomic number and mass than uranium was, in fact, an isotope of the element barium which has an atomic number and mass not very different from half that of uranium.

Immediately afterwards Dr O. Frisch[9] and Professor Lise Meitner[10] pointed out that this discovery could only mean that, when uranium was bombarded by neutrons, a nuclear reaction took place of a kind utterly different from any so far studied and that the

[9] Otto Frisch, a German refugee.

[10] Prof. Lise Meitner, woman-physicist and life long co-worker of Otto Hahn. She was turned out of Germany in the Jewish purge.

uranium nucleus split into two parts of roughly equal mass. This phenomenon, for which they proposed the name "nuclear fission", could be explained in terms of the theory of nuclear reactions which had been developed by Professor Bohr in the preceding years. They also pointed out that the fragments of the uranium nucleus would fly apart with great energy and this prediction was given a direct proof by experiments carried out by Dr Frisch in Copenhagen. Confirmation of the reality of the fission process with uranium, and of the great energy released which accompanied it, was obtained by Professor Joliot in Paris independently (and at nearly the same time) and by other physicists throughout the world as soon as the original work was known to them.

Very shortly afterwards, in the spring of 1939, Professor Joliot and his collaborators Drs Halban and Kowarski gave an experimental proof of the additional fact, which was expected on theoretical grounds, that when the fission of uranium takes place a number of free neutrons is also produced. Their first experiments showed this number to be about 3. Experiments of the same types were carried out by Drs Anderson, Fermi[11], Hanstein, Szilard[12] and Zinn in the U. S. A., and independent confirmation was obtained of the fact that more than one free neutron is produced for each fission of a uranium nucleus.

It was immediately recognized that this discovery was of the very greatest significance and that, for the first time, there was an experimental basis for the hope that the useful realization of the enormous store of atomic energy in matter could be achieved. Not only did the fission reaction provide the large amount of energy that was calculated from the difference in mass of the reactants and products, but the liberation of more than one new neutron each time that a uranium nucleus underwent fission made possible the continuation of the reaction by the development of a chain process once the initial step had been taken. Such a chain process would enable the reaction, in a suitable mass of uranium, to take place at an ever-increasing rate and would involve so many atoms that there would be a sensible, and indeed possibly an overwhelming, liberation of energy. The whole process could, furthermore, be started by the application of only a minute fraction of the energy that would be liberated and the difficulty, hitherto encountered in nuclear reactions, of obtaining an overall gain in energy would be eliminated.

It was therefore only natural that there should be an outburst of activity in most of the physics laboratories of the world with a spate of publications in the scientific press. This continued until the outbreak of war, when an increasing sense of the great potential value of this work imposed restrictions.

Certain important facts emerged from the work that was published during this period and theoretical conclusions and expectations were announced but it is hardly possible to give any strictly chronological account of them. The work was done in so many laboratories and the results, sometimes in a very preliminary form, were communicated to so many journals and published at such varying intervals after communication that details of priority cannot be clearly settled. But reference should be made to the visit which Professor Bohr paid to the U. S. A. from January till May, 1939. He was able to report directly to American physicists the experiments carried out by Hahn, Frisch and Meitner and their suggested interpretation of the results. In addition, while in the U. S. A., Bohr developed and published, in collaboration with Professor J. A. Wheeler of Princeton University, New Jersey, a theory of the fission process.

One important prediction which was made from this theory related to the different behaviour of the various isotopes of uranium. This element consists, for much the greater part (99·3 per cent.), of atoms of mass number 238 but there is also an isotope (0·7 per cent.) of mass 235 and a very small proportion (0·008 per cent.) of an isotope of mass 234. The first two, which are conveniently designated by the symbols U.238 and U.235 respectively, are the most important in connection with the uranium fission project. Bohr predicted, in February, 1939, that the common isotope, U.238, would be expected to undergo fission only when the bombarding neutrons had a high energy but that the rarer U.235 isotope[13] would behave differently in that it would not only show this reaction with high energy neutrons but in addition would be particularly liable to undergo fission when the energy, and therefore the velocity, of the bombarding neutrons was very low. This prediction was, in fact, confirmed in March, 1940, by experiments carried out by Nier of Minnesota and Booth, Dunning and Grosse of Columbia University, New York. They used a sample of uranium in which the content of U. 235 had been increased above the normal value by means of Nier's mass-spectrograph.

[11] E. Fermi, Nobel Laureate, most famous Italian physicist of present times who was the first to use neutrons for producing 'Transuranic Element'. It is said that when he discovered element No. 93, now provisionally called Neptunium, he proposed to Mussolini that it should be called Mussolinium in his honour. But Mussolini did not agree, as the element was "Unstable". Fermi was awarded Nobel Prize in 1939, and ran away to U.S.A., when he went to Stockholm to receive the award.

[12] H. Szilard, German refugee physicist.

[13] Next to the discovery of the fission phenomena, the discovery of the importance of U.235 which is due to Bohr, is the most important work in the development of the Atom Bomb.

It is relevant, at this point, to refer to a different phenomenon shown by the U.238 isotope when bombarded by neutrons of one rather narrowly defined energy value which is intermediate between the very high energy required to cause fission of this isotope and the very low energy which is most effective in causing fission of U.235. Neutrons which have this so-called "resonance" energy are very strongly absorbed by the U.238 nucleus but fission does not follow. Instead the new nucleus, which now has a mass number 239, emits two electrons in successive steps and is thereby converted first to an isotope of an element with atomic number 93 (for which the name "neptunium" has been suggested) and then to one of an element with atomic number 94. This latter has, provisionally, been named "plutonium" and the isotope formed from U.238 after resonance capture of a neutron may be represented by the symbol Pu.239. Neptunium and plutonium are true "trans-uranium" elements, of the type suggested by Fermi, and are not found in nature. Of the two, Pu.239 is of particular interest in connection with the general problem of fission and the release of atomic energy because it could be expected, from the Bohr-Wheeler theory, to show the same sort of properties as U.235 and to be capable of undergoing fission with the greatest ease when bombarded by neutrons of very low energy.

Reference must also be made to the fact that the three nuclear species U.235, U.238 and Pu.239 are not the only ones that can undergo fission. The two elements next below uranium in the atomic series were also shown to have this same property. Thorium, with atomic number 90 and consisting of one isotope only of atomic mass 232, behaves in the same way as U.238 and fission can only be brought about when the bombarding neutrons have very high energy. The very rare radio-active element protactinium, with atomic number 91 and atomic mass 231, behaves, as regards fission, in a manner intermediate between U.235 and U.238. These facts, again, are all explicable in terms of the Bohr-Wheeler theory which enumerates certain general rules covering the behaviour to be expected with regard to fission of any heavy nucleus known or unknown.

Chain reaction and the Atomic Bomb

The foregoing survey of the development of atomic and nuclear physics, though necessarily brief and incomplete, has traced the growth of the idea that there are enormous reserves of energy in all matter ; that these are of a nature quite different from those involved in chemical processes, such as the burning of coal or oil or the detonation of T.N.T. or other explosives, and that the nuclear reactions by which they are released are more comparable to those occurring in the sun or stars or in the natural radio-active elements found on the earth.

While this idea has been formed and steadily strengthened since the discovery of the phenomenon of radio-activity at the end of last century it is only since the discovery, reported at the beginning of 1939, of the special phenomenon of fission that a way has been clearly seen by which this atomic or nuclear energy in matter could be released, controlled and put to use by man.

In recent years the enormous effort expended on the solution of this problem, practically all of which has been borne by the U. S. A., has been concentrated on the development of an atomic bomb. Considerations of security make it impossible to disclose many of the details of this work but, in what follows, some indication is given of the share in it which has been carried out in Britain. Before doing this, however, it may be worth summarizing the nature of the problems relating to the use of fission, either to produce a violent explosion or to liberate atomic energy under controlled conditions, as they appeared when the work was organized, with a new sense of its urgency and importance, at the beginning of the war.

It was generally accepted that a chain reaction might be obtained in uranium which would yield enormous amounts of energy. This, on a basis of equal weights, would be millions of times greater than that produced by the combustion of coal or oil. But it was realized that, if this chain reaction was to be divergent and self-sustaining, certain critical conditions must be satisfied. In the first place the system as a whole must be of such a size that there was not too great a probability that neutrons, produced in the fission process, would escape from the system and so be unable to take any further part in the chain process. Secondly the system must not contain more than a limited amount of material that would absorb neutrons and, in this way again, remove their chance of contributing to the divergent fission chain reaction. Thirdly, the fact was appreciated that, if the reaction was not to "run away", it was essential to make use of neutrons of very low energy in the individual steps of the chain process. Only then would it be possible to introduce methods which would allow the rate of development of the process to be controlled. The neutrons produced when fission occurs have very high energies but this is dissipated as a result of elastic collisions with the nuclei of other atoms that may be present. Professor Joliot and his co-workers in Paris, Professor Fermi and other physicists in the U. S. A. and Professor Sir George Thomson and his colleagues in London were giving thought to the possibility of using a mixture of uranium and some suitable "slowing-

down" medium arranged in such a way that the fast neutrons produced by fission would lose their energy by elastic collisions before initiating further fission in the uranium. A suitable "slowing-down" medium must, above all, not have any large probability of capturing a neutron and its atoms should be of as small mass as possible in order to get the maximum rate of loss of energy in the neutrons through elastic collisions. The most suitable materials to fulfil both these conditions were "heavy hydrogen" or its compound "heavy water", helium, beryllium and carbon.

At the beginning of 1940 Dr Frisch and Professor Peierls, of Birmingham University, and Professor Sir James Chadwick, of Liverpool University, independently called attention to the possibility of producing a military weapon of unprecedented power. They pointed out that the slow neutron chain reaction would not produce explosive effects much greater than those obtained with ordinary explosive but that if a chain reaction with fast neutrons could be realised the explosive effects might be enormous. It was realized that ordinary uranium would not be suitable, for even if a fast chain reaction could be realized with it a very large quantity of metal would be required. On the other hand, the isotope U.235, if it could be separated, offered great possibilities. It seemed that the amount required to make a bomb would not be very large, certainly between one and one hundred kilograms, and rough calculations of the energy released showed that the explosion of such a bomb might be equivalent to many thousands of tons of T. N. T.

The explosion of an atomic bomb is very different in its mechanism from the ordinary chemical explosion for it can occur only if the quantity of U.235 is greater than a certain critical amount. This is because the reaction depends on the conservation of the neutrons produced in the fissions. In a block of pure, or nearly pure, U.235 the neutrons will either be absorbed in the mass of metal, producing new fissions, or they will escape into the outer air, thus being wasted and useless for propagating the reaction. The proportion of neutrons which escape can be reduced by increasing the size of the block of metal, since the production of neutrons is a volume effect and will therefore increase more rapidly with size than the loss by escape, which is a surface effect. It follows that if the explosion is possible it will require a certain minimum amount of material, which is called the critical size. The chain reaction will develop so fully that an explosion occurs only if the quantity of U.235 is greater than this critical amount. Quantities less than this are quite stable and perfectly safe. On the other hand, if the amount of material exceeds the critical size it is unstable and a reaction will develop and multiply itself with enormous rapidity, resulting in an explosion of unprecedented violence. Thus all that is necessary to detonate a bomb of U.235 is to bring together two pieces each less than the critical size but which when in contact form an amount exceeding it.

If an appreciable fraction of the atoms in a mass of U.235 undergo fission within a very short time the amount of energy liberated will be so great that the mass will attain a temperature of many million degrees and a pressure of many millions of atmospheres. It will consequently expand with very great rapidity. As the density of the mass decreases the neutrons can escape more easily from it, and the chain reaction will come to an end. In order to release an appreciable fraction of the available energy, it is therefore necessary that the reaction should develop so rapidly that a substantial part of the material can react before the system has time to fly apart. The neutrons produced in the fission process are fast enough to fulfil this condition (but not if they are slowed down by artificial means as mentioned in the paragraphs above).

The interval of time between the beginning and the end of the nuclear reaction is exceedingly brief. In this interval the mass will have expanded so much that the nuclear reaction breaks off, owing to the escape of neutrons. During this interval a substantial part of the mass of U.235 should undergo fission, releasing a large amount of energy. If only one pound of U.235 is affected this release of energy will be as much as from 8,000 tons of T. N. T.

The Realization of the Atomic Bomb. British Activities and Organization

(a) *Professor Sir George Thomson's Committee*

A committee of scientists, with Professor Sir George Thomson as chairman, was set up in April, 1940, originally under the Air Ministry and later under the Ministry of Aircraft Production. This committee was instructed to examine the whole problem, to co-ordinate work in progress and to report, as soon as possible, whether the possibilities of producing atomic bombs during this war, and their military effect, were sufficient to justify the necessary diversion of effort for this purpose.

The first step to be taken was to establish the nuclear data on which depended the possibility of an atomic bomb and which determined its size. This work had already begun at Liverpool early in 1940 under Professor Sir James Chadwick and it was now pushed on more rapidly with Drs Frisch and Rotblat as his senior collaborators. As the work developed and further problems appeared, it was extended to

the Cavendish Laboratory, Cambridge, under Drs Feather and Bretscher. This also had the advantage of providing an insurance against possible interruption from the effects of enemy bombing, to which the Liverpool laboratory was somewhat exposed. The many theoretical aspects of the problem were investigated by Professor Peierls, assisted by Dr Fuchs and others. They used the experimental data provided by Liverpool and Cambridge to calculate the critical size of the bomb, they examined the mechanics of the reaction, and calculated the amount of energy likely to be released in an atomic explosion, studying the conditions for increasing the amount.

This was clearly only one side of the problem for it would not have been of immediate practical use to show that an atomic bomb was feasible provided that a certain quantity of U.235 were available unless it could also be shown that there was a reasonable possibility of separating such a quantity of U.235 from ordinary uranium and in a reasonable time. This aspect of the problem was also considered by the Committee. In the early stages of the work not much actual experiment could be done owing to the scarcity of men and of facilities, but one method of separation was examined at Liverpool and shown to be unpromising. There are of course several methods available for separating isotopes on a laboratory scale. These were examined very carefully by the Committee, having in mind that it was essential to select and concentrate on what was likely to be the most economical method, owing to the fact that the manpower and industrial resources of Britain were already wholly engaged on production for immediate war needs. The Committee came to the conclusion that the gaseous diffusion method was by far the most promising for large scale production. It is based on physical principles which have long been fully understood and which are easily amenable to calculation, and it seemed likely to make fewer demands for highly-skilled precision work.

Research on this method of separation was taken up by a team of workers under the direction of Dr F. E. Simon in the Clarendon laboratory, Oxford. They were aided on the theoretical aspects by Professor Peierls and his group, and on the chemical side by Professor W. N. Haworth and a group of men under his direction in the Chemistry Department, Birmingham University. The Metropolitan-Vickers Electrical Company and Imperial Chemical Industries Ltd. were consulted on the many technical questions which were involved. Some experimental work on the diffusion method was also started at Imperial College, London University.

By the early summer of 1941, the Committee decided that the feasibility of a military weapon based on atomic energy was definitely established and that this weapon had unprecedented powers of destruction, that a method of producing the amounts of material required was in view, and that a fair estimate of the industrial effort needed to accomplish the project could be given. Accordingly, the Committee drew up a report dated July 15, 1941, which summarized its findings and which made recommendations for the prosecution of the project on a large scale. By agreement between the Minister of Aircraft Production and the Lord President of the Council, this report was referred to the Scientific Advisory Committee of the War Cabinet of which Lord Hankey was the Chairman.

It is proper at this point to consider in general terms what had been done and what remained to be done. The experiments on the nuclear properties of uranium had confirmed that ordinary uranium itself would be useless for the purpose of an atomic bomb and that it would be necessary to use the isotope U.235 which is present in ordinary uranium only to the extent of 0·7 per cent. They had further shown that if pure or nearly pure U.235 were available in sufficient bulk a chain reaction could develop which would result in an explosion of extreme violence. The data which had been obtained were sufficient to give an estimate of the amount of U.235 required, but this estimate was very rough and the critical size was known only to a factor of three. The theoretical work had confirmed the early result that the amount of energy released in an atomic explosion would be very large compared with the effect of ordinary bombs. Calculations had been made on the effect of "tampers" and on the best size of bomb. The method of assembly of the material for use as a weapon and the method of fuzing had been considered, but no experiments had been made. On the problem of production of this material, U.235, it had been decided to concentrate on the gaseous diffusion method, and research and development on some aspects had shown considerable promise. A scheme had been put forward by Dr Simon and Professor Peierls which had proceeded to the first stage of design. Leading experts of industrial firms had been consulted who had agreed that it should be possible to build a satisfactory plant, although difficulties were to be anticipated. Estimates were given for the cost of a plant to provide adequate quantities of U.235 and for the time required to build it.

In short, the Committee was completely convinced that an atomic bomb depending on the fission of U.235 was feasible and that its effect would be comparable with that of some thousands of tons of T. N. T. and that a method of separation of U.235 from ordinary uranium could be realized on a large scale, so that sufficient quantities of the material could be obtained. Admittedly, a great deal of

work remained to be done on all aspects of the project. More precise nuclear data were required so that, for example, the critical size could be estimated with better precision ; some points needed confirmation ; methods of assembly and of fuzing of the material had to be thoroughly examined. The main problem, however, was the design and construction of a plant for the production of the material, and this most essential part of the project was only in its early stages.

A different but important aspect of the application of the fission of uranium was also reviewed by the Committee. This was the possibility, mentioned in a previous section of this statement, of finding conditions under which a mixture of uranium and some suitable "slowing-down" medium might give a neutron chain reaction in which the release of energy was obtained in a controlled way. This work was being carried out at Cambridge by Drs Halban and Kowarski.

These two French physicists had been sent by Professor Joliot to this country at the time of the fall of France in June, 1940. They brought with them the 165 litres of "heavy-water"—practically the whole world stock of this material—which the French Government had bought from the Norsk Hydro Company just before the invasion of Norway. Drs Halban and Kowarski were instructed by Professor Joliot to make every effort to get in England the necessary facilities to enable them to carry out, with the co-operation of the British Government, and in the joint interest of the Allies, a crucial experiment which had been planned in Paris and for which the "heavy-water" had been acquired. Facilities were provided at the Cavendish Laboratory, Cambridge, and, by December, 1940, they produced strong evidence that, in a system composed of uranium oxide (as actually used) or uranium metal with "heavy-water" as the slowing-down medium, a divergent slow neutron fission chain reaction would be realised if the system were of sufficient size. It seemed likely that, if uranium metal were used, this critical size would involve not more than a few tons of "heavy-water".

The Committee concluded that this work had great potential interest for power production but that this particular application was not likely to be developed in time for use in the war. It was, however, recognised that the slow neutron work had a bearing on the military project, for the plutonium which would be produced in such a system could be extracted chemically and might be capable of use in an atomic bomb instead of U.235. The difficulties in the way of building a slow neutron system seemed to be prohibitive at that time. In order to produce the quantities of plutonium which it was guessed, from analogy with U.235, might be required for a bomb, many tons of uranium and many tons of heavy water would have been necessary. The latter practically would have demanded a major industrial effort.

During this period, April, 1940—July, 1941, similar problems were occupying the minds of American scientists. Contact was maintained partly by the transmission of reports through the normal scientific liaison machine and partly by visits in both directions by scientists on general scientific missions. Professor Bainbridge, of the National Defence Research Committee of America (N. D. R. C.), was in England in April, 1941, and Professor Lauritsen (N. D. R. C.), was in England in July of the same year on general scientific matters. Both were invited to attend meetings of Sir George Thomson's Committee.

(b) *Directorate of the Tube Alloys, D. S. I. R.*

The Scientific Advisory Committee of the War Cabinet, of which Lord Hankey was the Chairman, endorsed the view of Sir George Thomson's Committee on the importance of the atomic bomb, with the result that Mr Churchill, who had been kept informed on the developments by Lord Cherwell, asked Sir John Anderson, in September, 1941, to undertake personal responsibility for the supervision of this project as one of great urgency and secrecy. To advise him he set up, under his chairmanship, a Consultative Council of which the members were the Chairman of the Scientific Advisory Committee of the War Cabinet (Lord Hankey and later Mr R. A. Butler), the President of the Royal Society (Sir Henry Dale), the Secretary of the Department of Scientific and Industrial Research (Sir Edward Appleton) and Lord Cherwell. To ensure continuity the Minister of Aircraft Production, Lord Brabazon of Tara, served on this Council at the beginning.

The direction of the work was entrusted to a new Division of the Department of Scientific and Industrial Research and thus fell under the general administrative charge of Sir Edward Appleton as Secretary of the Department. It was known, for reasons of security, as the Directorate of Tube Alloys. Mr W. A. Akers was, at Sir John Anderson's request, released by the Board of Imperial Chemical Industries, Ltd., to act as Director, with direct access to the Minister on all questions of policy. Mr Akers had, as his deputy and principal assistant, Mr M. W. Perrin, who was also lent by I. C. I. Mr Akers was advised by a Technical Committee, under his chairmanship, composed of the scientists who were directing the different sections of the work and some others. The original members were Professor Sir James Chadwick, Professor Peierls and Drs Halban,

Simon and Slade, with Mr Perrin as secretary. Later it was joined by Sir Charles Darwin and Professors Cockcroft, Oliphant and Feather.

(c) *Visit of U. S. Mission to Britain, November, 1941.*

In November, 1941, at the time when the new T. A. (Tube Alloys) organisation was set up, an American mission, composed of Professors Pegram and Urey, of Columbia University, came to this country to study the experimental and theoretical work which had been done on the T. A. project, to learn our ideas for future work and to agree on arrangements for complete and rapid interchange of information. They visited all the establishments where T. A. work was in progress and took part in a meeting of the new T. A. Technical Committee at which progress was reviewed and new programmes discussed.

(d) *Visit of British T. A. Mission to U. S. A., February-April, 1942.*

Under the new organisation a great extension of the scale of work, both in university and industrial laboratories, was started. In the U. S. A. also a greatly intensified T. A. effort had followed the return of Professors Pegram and Urey from England. A mission composed of Mr Akers, Dr Halban, Professor Peierls and Dr Simon visited America at the beginning of 1942 to ensure that the programmes planned for the U. K. were co-ordinated as efficiently as possible with the American work.

Every section of the American programme was examined in detail and it was already clear that the new American T. A. organisation intended to make the fullest use of the enormous resources available in the universities and in industry.

(e) *British T. A. Programme.*

It was clear in 1942 that, even though granted very high priority, the scale upon which T. A. research and development could be undertaken in the U. K. must be far smaller than in America. A large proportion of the qualified physicists was occupied in other urgent war work and the industrial resources of Britain were engaged, at that time, in war production to a much greater extent than was the case in the U. S. A.

Consequently it was necessary to limit the field of T. A. investigation. Broadly the programmes chosen were:

Determination of essential nuclear physical data.

Theoretical investigations into the chain reaction in an atomic bomb, the dimensions and design of a bomb and its blast effect.

The gaseous diffusion U.235 separation process. This included theoretical and experimental research on the process, the design and construction of prototype machines, the manufacture of materials needed, studies on materials of construction, etc.

Investigation of slow neutron divergent systems, especially with "heavy-water" as the slowing-down medium.

The manufacture of uranium metal for the slow neutron systems or "piles".

The manufacture of "heavy-water".

(i) *Location of Work—Experimental determination of nuclear physical data.*

The research teams at Liverpool and Cambridge Universities were considerably strengthened and small programmes were started at Bristol and Manchester Universities.

Professor Sir James Chadwick exercised general supervision over all this work.

Slow Neutron systems

This work continued at Cambridge under Drs Halban and Kowarski with the collaboration of Dr Bretscher.

Theoretical investigations into chain reaction, etc.

Professor Peierls and his team continued their studies at Birmingham, with collaboration, on special problems, with Professor Dirac of Cambridge.

Later, when Professor Peierls moved to U. S. A., Dr A. H. Wilson led this group.

The Gaseous Diffusion Process[14]*—University Research*

The experimental work was under the general direction of Dr Simon. His extended team at the Clarendon Laboratory had, as leaders, Mr Arms and Drs Kurti and Kuhn. The theoretical study of the process remained in the hands of Professor Peierls and his group at Birmingham. Also at Birmingham University Professor Haworth, who had been active in T. A. from the days of the Thomson Committee, had a group working on a number of chemical problems connected with the diffusion project.

[14] The Gaseous Diffusion Process:—This process, which is based on a phenomena called Thermal Diffusion, is the most powerful method for separation of isotopes. It was invented by a German physicist, R. Clusius in 1939, and its study was immediately taken up in the U.S.A., England and France. By this method, Chlorine 35 can be separated from Chlorine 37 completely in course of a few hours, a feat which defied the skill of experimenters for over 40 years. The process requires high columns and enormous quantities of refriegerating material.

Research and Development in Industrial Establishments.

The Metropolitan-Vickers Electrical Co. Ltd. accepted a contract for the design and construction of certain prototype machines embodying the principles worked out by Dr Simon and Professor Peierls. The sucessful construction of these machines was a considerable technical achievement in view of the novel features contained in them. They were later abandoned in favour of a simpler design which offered certain advantages in operation.

Imperial Chemical Industries Ltd. (I. C. I.) were entrusted with the contract for the development of the diffusion plant as a whole, and the work was carried out by the Billingham Division of that company. This programme was a very extensive one as it covered everything involved in the design of a complete plant, including the working out of flow-sheets, research on materials of construction and the development of new types of valves, instruments, etc., to meet novel conditions.

In this work they were assisted by the Metals Division of I. C. I., which studied various manufacturing processes. I. C. I. Metals Ltd. had, as subcontractors, Percy Lund Humphries and Co. Ltd. and the Sun Engraving Co. Ltd., co-ordinated by Dr Banks whose services were made available by the Printing and Allied Trades Research Association. Metallisation Ltd. also made a valuable contribution to this section of the work. Processes for the manufacture of the many special chemicals required were worked out by the General Chemicals Division of I. C. I. assisted by the Dyestuffs Division. The Mond Nickel Co. Ltd., under a separate contract, made a very successful investigation of certain metallurgical problems.

Although some of these research programmes will be carried on a little longer, largely in order to establish optimum conditions, I. C. I. Billingham Division has been able to close down the main programme after producing flow-sheets and designs for diffusion plants operating over a fairly wide range of conditions. In broad outline the plant is, of course, similar to the American diffusion plant now in operation, but it embodies certain novel features.

The manufacture of Uranium Metal

I. C. I. (General Chemicals) Ltd. undertook the manufacture of uranium metal and succeeded in developing a satisfactory method. The conversion of the metal into rods, as required for a "pile", was tackled by I. C. I. Metals Division. It soon became apparent that many problems required study in connection with the physical, metallurgical and chemical properties of the metal. Research on these points was undertaken by the National Physical Laboratory, Dr Simon at Oxford with a sub-group at Birmingham, the British Non-Ferrous Metals Research Association, Dr Orowan at Cambridge and the Alkali Division of I. C. I.

Heavy Water

I. C. I. Billingham Division, which had some experience in the separation of "heavy water" on a laboratory scale, was asked to prepare a scheme for the production of this material on a large scale. After examining various methods they reported that the most suitable process to adopt in this country, if speed of construction and certainty of operation were paramount, was the electrolytic process incorporating the vapour phase catalytic exchange principle introduced by Professor Taylor of Princeton University, U. S. A. Flow-sheets and designs were prepared for a plant in which the exchange system was of a novel design believed to be simpler and more efficient than any of those hitherto used or suggested.

Electro-Magnetic Method

Through the interchange of information we were aware of the remarkable development work which was being carried on at the University of California under Professor E. O. Lawrence, with the object of converting the mass spectrograph, used for the separation of isotopes in minute quantities, into a large-scale production apparatus. But it was decided not to start any corresponding research in this country as the physicist most suitable for this work, Professor Oliphant of Birmingham, was engaged in other urgent war work.

In July, 1943 it was possible to release him from that work so that it was decided to start a research programme at Birmingham on this method. Before work had really started Professor Oliphant visited America in connection with discussion on a closer integration of British and American T. A. efforts, in which it was agreed, as described below, that the most efficient course to follow, in the joint interest, was for Professor Oliphant and most of his team to move to U. S. A. The British electro-magnetic programme was therefore abandoned.

After Professor Oliphant's return to this country in March, 1945 it was decided to arrange for research to be started on some of the electrical engineering problems involved in this type of plant. With this object research contracts have been placed with the British Thomson-Houston Company, the General Electric Company and Metropolitan-Vickers Electrical Company. In addition the first and last of these companies had already given considerable assistance by lending to the British T. A. organisa-

tion the services of Dr K. J. R. Wilkinson, Dr T. E. Allibone and other physicists and engineers.

(ii) *Co-ordination of Programmes.*

It will be seen, from the account of the diffusion plant research project, that many university and industrial teams were concerned, so that proper co-ordination of the work became an important matter. The same applied to the work on the production of uranium metal and its metallurgy. It was also evident that some of the chemical research carried out for one project would be of interest in connection with another. To ensure satisfactory co-ordination of the work certain committees and panels were set up.

The diffusion work was dealt with by the Diffusion Project Committee reporting to the T. A. Technical Committee.

The members of this Diffusion Committee were:

Mr W. A. Akers, Director T.A. (D.S.I.R.)—*Chairman.*
Major K. Gordon (later Dr G. I. Higson), I.C.I. Billingham Division—*Dy. Chairman.*
Dr F. E. Simon, Oxford University.
Mr H. S. Arms, Oxford University.
Professor R. Peierls (later Dr A. H. Wilson), Birmingham University.
Mr J. D. Brown, I.C.I. Billingham Division.
Dr J. B. Harding, I.C.I. Billingham Division.
Mr C. F. Kearton, I.C.I. Billingham Division.
Mr S. Labrow, I.C.I. Billingham Division.
Mr J. R. Park, I.C.I. Billingham Division.
Mr N. Elce, Metropolitan-Vikers Electrical Co.
Mr H. Smethurst, Metropolitan-Vickers Electrical Co.
Mr M. J. S. Clapham, I.C.I. Metals Division.
Mr S. S. Smith, I.C.I. Metals Division.
Mr M. W. Perrin, T.A. Directorate (D.S.I.R.)—*Secretary.*

The chemical research was co-ordinated by a panel reporting to the T. A. Technical Committee. The constitution of this Panel was:—

Professor W. N. Haworth, Birmingham University—*Chairman.*
Dr R. E. Slade, I.C.I.—*Vice-Chairman.*
Dr F. E. Simon, Oxford University.
Dr J. P. Baxter, I.C.I. General Chemical Division.
Dr J. Ferguson, I.C.I. Alkali Division.
Mr J. R. Park, I.C.I. Billingham Division.
Mr M. W. Perrin, T.A. Directorate (D.S.I.R.)—*Secretary.*

Uranium metal production and metallurgical matters were handled by a Metal Panel, whose members were:—

Mr E. Colbeck, I.C.I. Alkali Division—*Chairman.*
Dr W. O. Alexander, I.C.I. Metals Division.
Dr N. P. Allen, National Physical Laboratory.
Mr G. L. Bailey, British Non-Ferrous Metals Research Association.
Dr A. M. Roberts, I.C.I. General Chemicals Division.
Dr F. E. Simon, Oxford University.
Mr D. C. G. Gattiker, T.A. Directorate (D.S.I.R.)—*Secretary.*

(iii) *Research Contracts. Patents.*

The contracts under which research is carried on in university laboratories contain clauses reserving exclusively to the Government all discoveries, inventions and other results arising from the work. In the case of researches carried on by industrial firms all results, inventions and developments in detail applicable within the T. A. field become exclusively the property of the Government. Where an invention is also usable outside the T. A. field provision has been made whereby its use outside the field can be made available to industry. It is within the discretion of the Government to decide whether or not a particular use is within or without the field. Questions relating to inventions and patents are dealt with by a small Patents Committee composed of:—

Mr A. Blok, D.S.I.R.—*Chairman.*
Mr W. A. Akers, Director T.A. (D.S.I.R.).
Mr M. W. Perrin, T.A. Directorate (D.S.I.R.)

(f) *Joint British-Canadian-American Slow-Neutron Project in Canada.*

Towards the end of 1942 it was decided that the slow-neutron research in progress at Cambridge would proceed more quickly and efficiently if it were transferred to a place geographically nearer to Chicago where the corresponding American work was being carried out.

A proposal was made to the Canadian Government that a joint British-Canadian research establishlishment should be set up in Canada, to work in close touch with the American group. The Canadian Government welcomed the suggestion, with the result that, at the beginning of 1943, a large research establishment was set up in Montreal under the general direction of the National Research Council of Canada.

Practically the whole of the Cambridge group, under Dr Halban, was moved to Montreal, where

the research staff was rapidly augmented by many Canadian scientists, several new recruits from the United Kingdom and a certain number from the United States. The laboratory was at first directed by Dr Halban. He resigned this position early in 1944 and professor J. D. Cockcroft was appointed to succeed him.

During the Spring of 1944 the Americans joined actively in that project which now became a joint British-Canadian-American enterprise. Its scope was enlarged and in 1944 a site was selected on the Ottawa river, near Petawawa, Ontario, for the construction of a pilot scale "pile" using "heavy water", supplied by the U. S. Government, as the slowing-down medium.

This joint enterprise in Canada has been described more fully in statements issued by the Canadian Government. It represents a great contribution, both in men and money, by that Government to the development of this new branch of science and its applicatoin.

(g) *Transfer of British T. A. Research Groups to U. S. A.*

In August, 1943, Sir John Anderson visited America and discussed with the U. S. authorities the means by which the co-operation between the two countries might best be placed upon a more formal basis. Further discussions took place subsequently between President Roosevelt and Mr Churchill which led to the setting up of a Combined Policy Committee in Washington.

Professor Sir James Chadwick who was appointed Scientific Adviser to the British members of this committee examined, with those responsible for the scientific and technical direction of the American project, the question whether there were any further steps which could be taken, in the pooling of scientific and technical effort, which would accelerate the production of atomic bombs in the U. S. A.

As a result of these discussions it was decided to move to America a large number of the scientists working in England on T. A. in order that they might work in the appropriate American groups.

At this time Professor Bohr escaped from Denmark and the British Government appointed him as an adviser on scientific matters. His scientific advice on the T. A. project has been available both in this country and in the United States to the two Governments.

Professor Oliphant and his team from Birmingham University were moved to Berkeley to work with Professor Lawrence's group engaged in research on the electro-magnetic isotope separation project. They were joined by other physicists from Britain including Professor Massey of University College, London, Dr T. E. Allibone and Dr K. J. R. Wilkinson who worked partly at Berkeley and partly at the electro-magnetic separation plant itself. Dr Emeleus of Imperial College, London, Dr J. P. Baxter and others were transferred to the electro-magnetic plant. Dr Frisch from the Liverpool nuclear physics group and Dr Bretscher from the corresponding Cambridge section, together with some members of their teams, were moved into the great American T. A. research establishment at Los Alamos, which is described in American statements on the project. They were joined, at that time or later, by a number of other British scientists including Professor Peierls and Dr Penney, of Imperial College, London University. Professor Sir Geoffrey Taylor also paid several visits to this establishment.

The effect of these transfers, and others which were made to the Montreal project, was to close down entirely all work in the U. K. on the electro-magnetic process and to reduce almost to nothing the nuclear physical research. Nevertheless there is no doubt that this was the proper course to follow in the light of the decision which had been taken to give the highest priority to the production, in the shortest possible time, of an atomic bomb for use in this war.

TRIAL EXPLOSION OF THE ATOMIC BOMB

The first trial atomic bomb was touched off on July 16th, 1945. Sir Geoffrey Taylor, one of the group of British scientists who worked at the New Mexico atomic bomb laboratory, was twenty miles away from the 100-foot tower on which the bomb was mounted and described the explosion in these words, "We were provided with a strip of very dark glass to protect our eyes. This glass is so dark that at midday it makes the sun look like a little undeveloped dull green potato. At exactly the expected moment, I saw, through the dark glass, a brilliant ball of fire which was far brighter than the sun. In a second or two it died down to a brightness which seemed to be about that of the sun, so realizing that it must be lighting up the countryside I looked behind me and saw the scrub-covered hills 22 miles away from the bomb lighted up as though by a midday sun. Then I turned round and looked directly at the ball of fire. I saw it expand slowly, and begin to rise, growing fainter as it rose. Later it developed into a huge mushroomshaped cloud and soon reached a height of 40,000 feet."

—*Discovery*, September, 1945.

THE SCIENTIST'S UTOPIA*

One-world: The Scientist's Utopia

THAT a scientist is even asked to speak on Utopia, an imaginary island depicted by Sir Thomas More as enjoying a perfect social, legal and political system, speaks volumes for science, against the background of the present distracted world. The contribution which science has made—and should continue to make—towards the abolition of poverty and disease and to ensure a fuller and richer life has been the most potent reason for its growing recognition. The appreciation of these advantages as preeminently the gifts of science against the mess which is created in the world by diplomats and fanatical religious leaders is indeed helping to establish science in its exalted position. Even the havoes caused by the applications of science during this war will not be able to shake science from this position. The thinking world fully realizes that the message of science is not contained in the consternation caused by earthshaking effects of the atomic bomb or the devastation inflicted by its application as a political weapon. The real message is concealed in the silent desire of the scientist to see that even atomic energy, in fact any energy, should be harnessed to the good of mankind. By annihilating space and time and by overcoming other natural obstacles that divide peoples and countries and by steadfast devotion to truth, science has done more than anything else to bring the idea of "One-World" into prominence. It is for science now to shake off its philosophical detachment and assume its rightful position in shaping the destiny of man and translating this idea into action. Ideas such as Fatherhood of God and Brotherhood of Man constitute a metaphysical approach to the realization of this very ideal, but science has increased the possibilities of this ideal materializing in our actual life. An ideally perfect island, isolated from the rest of the wicked world is an impossibility. Perfection only in a part of the world, smacks in itself of an imperfect world. The concept of "One-World" is the scientist's Utopia and he should work with his usual steadfastness to translate this dream into a reality. Let it be clearly understood and there is no room for scepticism in this, that all Utopias of the scientist ultimately do materialize in time.

Narrow Patriotism and the Atomic Bomb

There is, however, one thing against which the scientist will have to guard himself and that is narrow patriotism. The atomic bomb and its great possibilities have already started controversies which if pursued unscientifically will sow the seed of another war that may very well means the end of civilization. Already some top rank scientists have proclaimed to the world that the atomic bomb cannot remain a secret for a long time. Most scientists who have specialized in nuclear physics and chemistry understand the mechanism underlying the production of atomic power. There may be gaps here and there but these can be filled easily by research by any intelligent worker in any part of the world. Unfathoming of such mysteries is indeed the privilege of science but the task must not be vitiated by a militant spirit. Science may dominate Nature, but it must not overawe Man, for that would mean its own undoing. The aim of science is definitely to harness the atomic energy to useful ends. If this is to remain a closed secret of Britain and the U. S. A., it is obvious that its applications for useful purposes will either be tabooed by law or remain very restricted in scope. A recent statement that the U. S. A., Canada and England will have the monopoly of atomic power and that the U. S. A. is not prepared to share the scientific knowledge regarding the atomic bomb with the rest of the world is indicative of how statesmen and politicians even in advanced countries can stop science from solving international problems of want and poverty. It is obvious that this secretiveness will have two definite effects. Firstly in the present setting of power politics it will lead Russia and other groups within its orbit to concentrate on research on this subject. And very soon the Soviets will be able to discover the secrets now being concealed from them with perhaps a few more things not known at present even to the Americans and the British. Secondly, it will lead the U. S. A. and Britain to make frantic efforts to improve upon their present technique ; and being victims of a common fear lest one should be outpaced by the other, both the groups of nations will concentrate upon discovering and utilizing this energy for destructive ends. The American and the British scientists have a clear duty before them of lodging an emphatic protest against this unscientific attitude of their Governments ; otherwise science will destroy all that it has created for the good of mankind. On no account should decent scientific men agree to a procedure of abject secrecy in a matter which has such enormous potentialities as the atomic energy.

Atomic Energy & Need for International Control

The courage of scientists, their honesty of purpose and the destiny of science cannot be held in

* Adapted from a Radio talk by Sir S. S. Bhatnagar, D.Sc., F.R.S., Director of Scientific and Industrial Research, C.S.I.R., Government of India.

doubt. If the scientists were forced to submit to secrecy in such a vital research, a Galileo will soon arise among them in order to smash political interference in matters of intellectual freedom. There is no reason to be surprised if it should evoke an upheaval of an unprecedented character in the usually peaceful portals of learned societies and universities. The knowledge that among the people of the earth only a chosen few will be allowed to know the secrets of atomic energy will make not only those who are in possession of the secret but also others who are in the know, live in a state of continual alarm. It will lead to endless wars and a race for armament of a magnitude unknown in human history. Indeed, one cannot think of a more effective method of destroying the high hopes raised by the Frisco Conference of winning a lasting peace. Neither art nor real science nor any other thing loved or valued by man could ever flourish in such conditions of life dominated by the primitive instinct of self-preservation. On the other hand, if the intelligent people of the world are consulted in the future control of atomic energy, they will undoubtedly vote against the exclusive control of this power by any one nation. They will all prefer an international control by people who have distinguished themselves by their stand in favour of peace and justice in the world. There is no doubt that this control will taboo the misuse of atomic power and encourage scientific research of a type which may lead to the banishment of poverty and want and help to establish on earth conditions of perfect peace and justice.

Political *versus* Economic Internationalism

Failure does not baffle a scientist, it only creates in him the urge for a better planned and more co-ordinated attack on the problem. The League of Nations which was created after the last war with a view to banishing war and to establishing the politician's Utopia on earth failed because it was essentially an Anglo-French-American solution which allowed the cancer of colonial imperialism to remain intact. The League failed because it did not conceive fully the ideas of oneness of the world and because it attempted to solve the world's problems primarily from the political standpoint. The scientists of the world have not given up the hope and they fervently expect another lead from responsible men of the world in which this approach will be not from the angle of political internationalism but from the point of view of economic internationalism in which not only the material resources of nations but their intellectual resources as well will form a part of wealth capable of international utilization on a planned basis. Economic internationalism cannot be conceived by any one nation alone or by a group of nations in isolation from the rest of the world. In fact, the fundamental principle which science and economics have arrived at is that no nation can reach its fullest development or even maintain its prosperity alone by itself. This emphasizes interdependence rather than independence as the aim of human endeavours. To a philosopher and scientist the fullest development of any nation means nothing else but a process of assimilation by that nation of all that is created by art, science and technology and which is capable of aiding human progress in all its phases.

Science and Politics

In this Utopia of "One-World" which the scientist envisages, political controversies will be examined not from a racial or parochial standpoint, nor even on the nobler basis of a mere emotional urge, but from the broader point of view of sound sense. They will be examined from the point of view of how they affect the world as an organic whole in which individual countries will constitute so many integrated parts. Culture instead of being Greek, Roman, Indian, Egyptian or British will rather acquire prominence as human culture. It may be a hotch-potch of a great many diverse achievements, but like the American race which has shown a unique genius for a racial and cultural synthesis in the modern-world it will be a distinct entity worth acquiring and developing.

Perhaps the most outstanding difference between the governments of the present world and that of this Utopia will be that the supreme government will not consist of, as at present in all the existing governments, aggressive nationalists or apathetic isolationists, but of people of much wider culture and outlook whose perspective will embrace the whole world as a family. Their intellectual and moral make-up will be reared on the necessary training in basic sciences and humanities so that they may be able to examine important issues correctly and dispassionately. Perhaps the method of election will be retained for returning people to positions of trust and responsibility, but with the changed outlook the test of the elections will not be dominated by local or national issues vis-a-vis world considerations. In this new civilization which may well be called the child of Applied Science, the scientist will have to shoulder responsibility for its stability and development. Those who control affairs of the world today have a training which fits them to be diplomats and executives. The scientists and philosophers are con-

sidered lesser men if they take interest in statecraft or development of the country. It is obvious that if we have to pursue philosophy, poetry and science in this civilization, not as mere pastimes but as nursing factors of human mind and character, then this government of the new world must have a fair representation of these comparatively absent factors in the various governments of the present world.

Under the influence of science, the world will mobilize all its resources as one unit and with the set purpose of liquidating poverty and raising the standard of living of the human race. When the object of the whole human race will be the advancement of humanity, national or party interests and clashes which breed hatred and war will become less and less and the desire for advancement of common welfare based on an appreciation of mutuality of interest will grow from more to more.

Science and Religion

In this "One-World" of the future, the conflict between religion and science, which waged so vigorously in the last cetury and which seems to have subsided in the present age on terms of mutual toleration, will acquire a new significance. At present the scientific man goes on with his job on the understanding that God never interferes. It may be that God must not interfere in scientific domain or that God cannot be a cypher in human affairs. The trend of physics shows that these two divergent ideas are perhaps capable of being synthesized and it looks certain that in the Utopia of the scientist, God and Science will be brought into a fertile union in which the idea of God instead of being diluted will be enriched. Idealism and Achievement—although two different words—will then acquire one meaning.

FAMINE AND DESTITUTION IN RURAL BENGAL.

K. P. CHATTOPADHYAY
PROF. OF ANTHROPOLOGY, CALCUTTA UNIVERSITY

THE sample survey of 400 villages in 40 sub-divisions of Bengal carried out during the second half of 1944 and in January, 1945 has yielded important data regarding the economic condition of the people of the province. The Revenue Department of the Government of Bengal had grouped the sub-divisions of the province into different classes according to their ideas of the degree of intensity of the famine. The survey carried out under my direction in the field in accordance with the design (based on the principle of random samples) prepared in the Indian Statistical Institute under the general technical guidance of Prof. Mahalanobis, included all the 12 sub-divisions in class I, *i.e.*, the very severely affected areas, 9 out of 14 in class II (*a*) and all 12 in class II (*b*), these being of the category of moderately affected areas, 4 out of 6 in class III said to be slightly affected, and 3 sub-divisions from the remaining areas stated to be very slightly affected or not at all. The survey revealed that the classification by the Revenue Department was not reliable; the results were much more in accord with a classification adopted by the Director of Industries, Government of Bengal. The material collected under my supervision was statistically analysed in the Indian Statistical Institute and the results have been given in a statistical report prepared under the guidance of Prof. Mahalanobis. The estimates used in this note are taken from that report but the conclusions drawn therefrom are entirely my own.

The economic condition of the people of Bengal has been unsatisfactory for the past few decades, and there has been in consequence, an appreciable proportion of destitute persons in the population. By the term "destitute" is meant those depending solely, or primarily on charity for their livelihood. It excludes those persons who have sunk below the subsistence level, but who are maintaining themselves otherwise than by mainly depending on charity. The case of such people are considered separately from that of destitutes as defined here.

In the course of the survey, the economic unit taken was the family, including only those members of it who shared in a common kitchen. In the estimates, also the term "family" is used, in consequence in this sense.

We do not possess exact data regarding the number of destitutes in 1941. But the census figures for 1931 reveal that as many as 1·07% of the entire population in Bengal came under this head in that year. If it is assumed that up to 1941 this proportion remained on an average the same, we can form an estimate of the increase in destitution in 1943. Against an expected figure of 5·9 lakhs we find an actual of 7·5 lakhs. Early in 1944 this figure had swelled to 10·76 lakhs as a result of the famine of 1943. This large number of over a million, includes infants, children, adults as well as aged persons. There are about 1·1 lakh of infants below the age of five. The earners of the

families of 48 thousands of them are dead or absent, of 28 thousands are invalids, and of 37 thousands are without work. Children over 5 and below 15 years of age among the destitutes number 3·87 lakhs. Of these 2·19 lakhs are without earners, 0·91 lakhs have their earning members invalids and the remaining 0·77 lakhs children depend on unemployed adults. There are also 1·43 lakhs adolescent and adult men and 2·92 lakhs women, in this economic group, besides 1·44 lakhs of persons aged 50 years or more.

The infants and children who have lost one parent or parents and earners through death or desertion and have survived, have in general been cared for by the surviving parent or by relatives and in a small number of cases by neighbours or in orphanages. Our survey was limited to families actually living in villages, and could not cover the units which had migrated to other areas in their entirety. The surveyors were unable to ascertain adequate details in such cases, and these cases have had to be left out in our table. In some cases where trace was obtained, they were reported to be living in destitution on charity ; in others it was stated that most of them had died. But the majority were not traceable. The total number of such families was however less than one per cent in our sample. Obviously several different problems have to be considered in any attempt at relief and rehabilitation of this varied group. The same measures will not meet the requirements of each group.

According to a report of the Government of Bengal[1], during the first half of June, "74 orphanages looked after 4,556 orphans", and "130 destitute homes . . . provided relief to 13,321 inmates". The orphans and destitutes living in these homes were in part at least not of the group living in villages, at that point of time. The number of orphans actually housed in orphanages is of the order of 1·7 per cent of infants and children without earner, and 0·9 per cent of the total number of infants and children who were destitute in 1944. The number of inmates of destitute homes other than orphans is a little over 2·2 per cent of the total number of adult destitutes. It is not clear from the brief note issued by the Government whether some children of age 5–15 are included in the figures for inmates of the Destitute Homes. In any case less than 2 per cent of the destitutes were looked after in Homes of any kind. It is apparent that the limit of orphanages and Homes for destitutes have not been reached.

The total number of destitutes has probably not changed much in 1945, as the number of semi-destitutes, *i.e.*, families living below the subsistence level, but somehow dragging on their existence– is very large, and the economic condition of Rural Bengal has steadily drawn a portion of them towards complete destitution during 1944-45. The agriculturist proper is a partial exception, but craftsmen, agricultural labourers, crop-sharers and petty traders have continued to go downhill, though at a slower pace than during 1943-44. The Famine Enquiry Commission have quoted a report of Sir John Megaw, Director General, Indian Medical Service, from an enquiry in 1933 stating that 31 per cent of the rural population of Bengal "were very badly nourished". We find also that (*a*) the total number of destitutes in January, 1943 was 7·5 lakhs as against an expected number of 5·9 lakhs on the assumption that destitution had grown in the same ratio as the increase of population, and (*b*) the economic conditions during 1944-45 have not been better for the poorer people, than during 1939-41. In 1944 over three-fourths of all agriculturists had less land than needed for subsistence as against 46% in 1930. The calculations have therefore been made on the basis of the figures for 1944.

It is not possible to indicate exactly what proportion of destitutes should be housed in Homes, and what proportion looked after otherwise.

In general, attempts should be made by sanctioning relief grants to ensure that the infants and children can live in their actual homes with a parent or parents. Such an arrangement will enable the children more easily later on, to take their place, however humble in society. An orphanage at its best is a dreary substitute for the home, and socially it yet sticks a stigma on the inmate which he cannot shake off easily in his social life. It is, however, inevitable for infants and children who do not have any parents living, nor really close relations (like grand-parents) who will use any rice dole or milk given, actually for those for whose benefit these are intended. Neighbours and distant relatives may prove worse than orphanage matrons in these respects.

We have seen that about 2 per cent were being looked after in Homes. But the actual number who may require such help in the matter of residence is much greater. A large proportion of destitute women with children (including infants) will probably find it more helpful at first to live in a Home where industrial (or vocational) training is given, while the children are also properly looked after in some attached institution. Later on they will be able to set up house independently.

The two problems–of setting up destitute women economically, and of looking after children should in fact be considered together. Attempts to house the mothers in one institution and to send the

[1] *Bengal Weekly*, Calcutta—June 27, 1945.

children to another home elsewhere will cause unnecessary hardship, and drive away from these centres, women who would otherwise come to them to stay and learn how to earn their livelihood. Such a separation will also weaken the social bonds which are needed for the rebuilding of the family as the final step in rehabilitation. Small annexes for children should therefore be attached to women's homes. It should be possible, with proper training to get a few among the women in such Homes to help in running the annexes for infants and children, and thus earn their keep. Composite institutions like these can deal with the orphan problem more easily and economically. Expenses in running and supervising several small homes will thereby be reduced. For success in running such institutions, a sufficient number of public spirited welfare workers are needed. The Nari Seva Sangha, a federated body of a large number of women's organisations has been doing useful work in this direction by training (*a*) women welfare workers who have already done some work among destitute women and (*b*) women whom the famine has driven into the ranks of the semi-destitute and who are willing to take up this type of occupation.

The requirements of the infants at the orphanages (including annexes), will be food and clothing, and care. The diet will have to include some milk. Normally infants below 5 years require three-fourths of a seer to one seer of milk daily for healthy development. It is however not likely that anything like this amount will be available for the infants of the destitute. Such an amount of milk is not now within reach of infants or children of adult workmen who are fully employed nor of the genteel poor working as petty clerks in business houses. The necessity should however be borne in mind in any long term planning.

For the children (age 5-15) in the Homes, education will be necessary in addition to food and clothing. Where there are schools near by, the children should be sent to these institutions and provided with books and other requisites. Where there are no schools, the centre itself should develop into one. For the older children, and women inmates of the linked institution, a training centre for helping them to earn their living will be needed. This matter will be considered in connection with the general problem of rehabilitation of adult destitutes.

Only a rough estimate of the number of such composite Homes can be formed. As noted earlier the survey does not reveal exact figures regarding infants and children who may with advantage be provided in such institutions. Careful local enquiries in some areas suggest that probably five per cent of the infants and children require to be looked after in orphanages. Homeless women with children will contribute perhaps an equal number. This last figure is a rough guess. The total of 10 per cent will not however be an overestimate.

If we accept these as our working basis, we have to arrange to look after permanently, *i.e.*, until they grow up, about 5 per cent of the infants and children and temporarily, *i.e.*, until the mothers are set up in a position to support their children—another 5 per cent of them. The total number of infants come out as 4,500 and of children as 22 thousand[2]. Five per cent of the adult and adolescent women is 15 thousand approximately. It has been noted earlier that relief grants for the remaining children will have to be provided. Hence in the matter of expenses, a moderate error in the estimates will not cause an appreciable difference in the total.

Temporary Homes for about 15 thousand women, and 13 thousand children and infants and permanent Homes (*i.e.*, for about 8-10 years) for another 13 thousand children and infants will have to be organised. If the Homes for women take about 100 women and the annexes or separate orphanages for children another 100, we shall require 150 composite institutions and 100 orphanages. As there are 86 sub-divisions in rural Bengal, on an average 3 institutions will be required in each area. Actually some sub-divisions will require more ; others less. Thus Tamluk with 1,900 destitute infants and 5,420 such children, without earners (dead mostly), and 8,900 adolescent or adult women in this condition will require Homes for 1,622 individuals as against Tangail's requirement for 850 such individuals and practically none in Satkhira. The figures in these three cases indicate that it will be sufficient to organise one small Home in Satkhira but Tangail will need 3 composite Homes and 2 orphanages and Tamluk about 10 such institutions. In the case of areas like Tamluk or Tangail where more than two or three Homes are needed, it may be possible to raise the size of the institutions to economise in overhead expenses. But it should be remembered that the major job of rehabilitation of the rest of the population will be to start Work Centres. It will be seen later that these workshops can be run more economically with a central institution linked closely with the Homes, as the coordinating body. Hence the question of distance between Homes will be important in that connection. Tamluk has an area of 749 and Tangail of 1,249 sq. miles. A distribution of 10 Homes in Tamluk will mean one per 75 sq. miles, *i.e.*, a little less than 10 miles apart. If the degree of affection is assumed to be uniform

[2] The Famine Enquiry Commission notes that "Preliminiary estimates by District Officers gave a total of over 30,000 but later this figure was reduced to 10,000."

all over Tamluk, obviously work centres could not be run at distances greater than this, as it would involve walking more than 10 miles daily. Actually the distance between work centres should be less. In Tangail the area is much bigger but the severity of the famine was much less and did not affect the sub-division uniformly. A total of 5 Homes means one per 250 sq. miles, *i.e.*, the units will be nearly 18 miles apart, on a uniform distribution. The actual location will depend on the relative intensity of destitution in different parts of each sub-division. As we shall see later a much larger number of work centres are needed to meet the full requirements of the destitutes.

We may now take up the major problem of rehabilitation of adult destitutes, so that they may be able to support the children and infants.

The adults fall into the following classes :—

(*a*) Invalids. (*c*) Ablebodied-men.
(*b*) Aged persons. (*d*) Ablebodied-women.

Clearly, the invalids will have to receive medical help, along with relief grants for food and clothing to enable them and their dependents to live. From the survey it appears that there are 3·08 lakhs persons dependent on invalid earners. As the average size of the destitute families is 3·1, we may assume one earner per family, as this is roughly the proportion of earners to dependents according to the census of 1941. The epidemic that was raging towards the end of 1943 and early in 1944 abated later on, but sickness and poverty have continued. So it is probable that many more earners have fallen sick, as against invalids who have grown well or are not living now. The estimates for dole and medical treatment may therefore be formed on the basis of the figures furnished by the survey.

Medical units for treatment, such as those organised by the various Relief Organisations which work under the Bengal Medical Relief Co-ordination Committee have brought down the expenses per head to less than five annas. Data furnished by our survey reveals that among the destitutes about 1 lakh families have invalid earners. Many of these cases of sickness will require hospital treatment. At the rate of one earner per family, we have one lakh invalids. A good proportion of them are hospital cases. Similar cases are also to be found among dependents.

Even if we take this number to be 10 thousand[3] and the duration of treatment required as three months, we have to conclude that there is need of at least one destitute hospital in each sub-division with about 30 beds. As the incidence of sickness is over 40 per cent in a year for the entire population surveyed, and as medical units such as those run by the Bengal Civil Protection Committee or the Peoples' Relief Committee can deal with 3,000 new cases per month we require two units in each sub-division only for the destitutes. In the interest of economy non-official relief centres may be subsidised to run such centres. This has proved very successful in the case of the Bengal Medical Relief Co-ordination Committee and its affiliated organisations (like the Bengal Civil Protection Committee and the People's Relief Committee).

The able-bodied adults and adolescents form a different group for whom the major problem is of giving occupation which will enable them to make their own living, and to support their dependents. This problem can be satisfactorily dealt with only after ascertaining the previous family occupation of the destitutes.

By the term "family occupation" is meant the major occupation by which the family lived. For the purpose of classification, the principal occupation of agriculture has been subdivided into four classes. The group "agriculture" represents mainly *ryots* who cultivate their own land or that taken on crop sharing basis. These people do not ordinarily work in other peoples' fields as labourers at any period. The group "agriculture and labour" consists of persons who work part of their time on their own (or share of) land and also as labourers in the fields of other persons. The group of "agricultural labourers" include persons who own no land or a negligible portion of it (say less than a fifth of an acre). There is another group which is not however homogeneous. It is labelled as "Non-cultivating Owners". Many rich land-owners employ hired labour or let out land on a share basis ; there are also widows and orphans who cannot themselves till the land and follow a similar arrangement. Obviously these are two different sub-groups. They have not however been shown separately in our tables owing to difficulties of tabulation.

The data collected leads to an estimate of 0·25 lakh destitute families of agriculturists ; of 0·14 lakh such families depending on agriculture and labour, 0·51 lakh families of agricultural labourers, and 0·06 lakh families of non-cultivating owners of this category. Fishermen had 0·11 lakh families among destitutes while craftsmen contributed 0·14 lakhs. Of the total number of destitutes, 27·8 per cent came from the agricultural group (all heads), while fishing and craft contributed 3·1 and 3·9 per cent respectively.

[3] The actual proportion of invalids who were incapable of any work due to serious illness was tabulated for six sub-divisions. The incidence of sickness noted later and the percentage of invalids is estimated on the basis of these figures.

The extent to which different communities have been affected is not however revealed by these percentages. As the bulk of our people, over 70 per cent are agriculturists, and the agricultural labourers and poor cultivators have been hard hit, a large proportion of the destitutes is contributed by them. The degree of destitution by occupation is given only by the proportion of destitutes of that group to the total population for that occupation. This index of destitution works out as 1·3 per cent for all agriculturists as against 7·75 for fishing and 2·70 for crafts. If the agricultural groups are considered separately agricultural labour with an index of 3·02 comes after fishing. The extremely high value of the index of destitution makes clear the urgency of relief and rehabilitation for fishermen[4].

It is a matter of regret that in relief operations this hard hit group did not get the necessary priority or special help during 1944. The recent reorganisation of the Fishery Department has improved the supply of necessities to a certain extent. It is however necessary that the different departments and officials on whose prompt action and intelligent co-operation the rehabilitation of this community depends, should realise the urgency of the problem.

Regarding the steps that are to be taken for rehabilitation, two lines are obvious—(*a*) To provide the means of livelihood to those who can work at home, and to help them to market their products, (*b*) To arrange for work centres for those who cannot make a living by work at home.

I shall take the case of the fishermen first as they are the worst affected group. Fishermen in different parts of Bengal follow on the whole the same technique in fishing. For fishing in shallow pools of limited size they need only traps and nets. These equipments also meet their need for fishing from river banks. But in the rainy season they need boats. Otherwise their activities are limited to a bare six months in the year and they have to depend on their scanty savings of the seasonal catch to drag through the barren months. At least one large cast-net and a dragnet for each family, and two or three plunge baskets and cage traps are necessary. One boat for every second family should be enough, as the ordinary destitute fisher family has not enough adults to man a boat. The other raw materials needed are bamboo, and yarn. The traps and nets are made by the fishermen. Boats will have of course to be built in special yards. For preserving nets and the timber of boats, fisher folk will need tar, and other extracts. In some areas local materials are available and the actual need may be of local purchase and supply, instead of import from elsewhere.

If fisher families are thus set up, the women of this community who are without earners will be able to make a livelihood in most areas. For, the women can help to make the small hand nets, the traps, and also to sell fish.

Arrangements will also have to be made for restoration of fishery rights. The fishing community as a whole lives in a precarious economic condition in Bengal, owing to the lack of legal protection. The fishery rights in small rivers and *beels* or even bigger waters in permanently settled areas belong to tenure holders or zeminders who lease them out to others. It appears from a report quoted by the Floud Commission that "there is no limit to what can be exacted" of the actual fishermen for their fishing rights. Zemindars and tenure holders generally settle fishery rights by auction to the highest bidder. The allied occupation of ferrying, which the fisher caste follows, suffers from the same handicap. Here the Government, like the Zemindar looks only to revenue. The highest bidder in most cases, in both occupations, is a rich *mahajan*, who employs the actual fishermen (and boatmen) to work as his servants for fixed wages or a fixed portion of the income. It is a very unjust practice and it impoverishes the actual toilers, to put some money into the pocket of the rich lease holder, the zemindar, and occasionally the State. Many fishermen have lost even what little rights they enjoyed, owing to the famine and continued high price of food-grains thereafter. They include destitutes as well as those on the verge of destitution.

Whatever help is given to the destitutes, of boats, nets and other materials, must obviously be in the nature of relief grants and not as loans carrying interest. Further, until the actual fishing operations start, the destitutes must receive doles. Otherwise they will eat up the capital for equipment. Where the fishermen live in groups of families in their own hamlets, quarters or villages, attempts should be made to organise them into co-operatives or unions. Official pressure may have the opposite effect. But if the help of local welfare workers is available, this added to official encouragement will lead to the growth of organised fishing, as against isolated fishing. Co-operatives may develop in this fashion and will help in purchase and distribution of raw materials as well as in marketing of the catch of fish.

In order to ensure future legal protection, it is essential that fishery rents should be settled by legislation. Further, it should be made compulsory to settle fishery rights on actual fishermen and preferably to organised groups of them. Similar protection is needed for ferry rights.

[4] The percentage of destitutes among rural transport workers appears to be nearly as high. But the sample obtained was too small for a definite conclusion. Transport includes river transport.

Regarding poor peasants who have lost all their land, the correct step is to restore the land. The community mainly affected have been those owning 0-2 acres of land. In the case of these destitutes any law giving partial relief is useless. The present enactment empowers the former owner to repurchase the lost land, up to a value of Rs.250/- only, by paying the price in ten instalments. But a person who has been reduced to destitution cannot afford to pay even a single instalment, nor the legal expenses needed for this repurchase. Normally, the cultivators who own such a small holding have to supplement their income by labour, which is uncertain, and in ordinary times, brings low wages. The Floud Commission in 1938-39 expressed the view "that 5 acres would be the minimum area required to keep an average family in reasonable comfort, but if the land is capable of growing nothing but *aman* paddy the area required would be about 8 acres". Hence it is easy to understand that the families living by agriculture and/or labour, and with holdings of 0-2 acres would be on the margin of want, and in a large proportion of cases, actually in want. They do not have any reserve in normal times. Under these circumstances, these families as well as those of this economic group of owners of 0-2 acres who have lost part of their land, cannot be expected to make any payment for repurchase. Nor can they afford to buy plough cattle needed for cultivation. The entire amount will have to be advanced by the State. For protection against further loss of land, the land so restored should be held in mortgage, free of interest by the State. As many members of this group have lost all their land, the upper limit of the value of repurchase should be raised to that of 2 acres,*i.e.*, Rs. 1,000/-.

Attempts should be made to get all such men to work together in cultivating their land. Consolidation of holdings should also be attempted on the lines followed in the Punjab, at the time of repurchase. If proper local help is available, such organisations should be enduring and help in collective purchase of manure, seed, and cattle, and of sale of produce. Rationing of the food supply for Bengal, and probably for India will have to be continued for some years to come. The present wasteful official arrangements can be improved if such peasants co-operative units grow up in villages. They will also help to put down sharp practices of traders and black market promoters.

An important step in attempting rehabilitation of small peasants is in the direction of protection from superior landlords. Many of these small peasants even when they have had all the land they formerly possessed, will be found to have an acreage insufficient for a living. Land sometimes however becomes available, through vacancy or otherwise. In general the landlord settles it on a prosperous non-cultivating owner in preference to the real cultivator of the soil. The result is that the same land becomes available to the small peasant, through a middleman who makes him a share cropper (bargadar). Even where the peasant himself has reclaimed some land by embankment or drainage the landlord has been found to settle it with others on better terms for himself. Instances have come to the notice of the writer where the peasants had to put up a fight against such injustice, not always with success. Legal protection of the ryot is essential in these matters. This point will be discussed in detail in a separate note on the land problem. Here it may be noted that the actual tiller of the soil should have first preference in the matter of vacant or reclaimed holdings.

This group of destitutes has one special problem, revealed by the comparative figures for men and women. So far as those who are unemployed are concerned, restoration of land and provision of equipment will solve the difficulties. There are however 14 thousand women and 27 thousand children and infants, of whom earners are dead. There are also 4 thousand women and 6 thousand men, as well as 9 thousand children dependent on invalid earners. Assuming one earner per family, the total population of this last group will consist of 6 thousand families. In this case, until the invalids become able to work, or if this is not possible, until children grow up, the cultivation will have to be carried on with the help of paid labourers. This will also be the case where adult earners are dead. As this will reduce the income from land some subsidiary occupations will have to be taught to them, so that a small income to supplement that from land may be available in this way. The occupations should be so selected that the old men of this group may be able to help in some of them. Subsidiary occupations are listed later on.

A similar problem exists for the group "Agriculture and Labour". Here the position is more serious. Restoration of land and furnishing of cattle, plough, and seed will not meet the requirements in many cases. No doubt the group of destitutes who are unemployed but not sick, will be able to earn their living when equipped with land. They will find occupation as agricultural labourers in their spare time (since their own land is too small to take more than 4-5 months in the year) in the fields of others. But the women and children depending on invalid earners, or where the earners are dead, will not get a living from the land that may be restored to them. Their land will have to be tilled by others and they themselves will need work suited to their capacity. There are 19 thousand destitute women

and children of whom the earners are dead and 4 thousands with invalid earners.

and other labourers. They cannot take to those occupations.

ESTIMATED NUMBER OF DESTITUTES IN MAY, 1944
BY AGE, SEX, CONDITION OF EARNERS AND FAMILY OCCUPATION IN JANUARY, 1943
(All figures in lakhs except in last column)

Family Occupation in 1943	Earners (Parents) dead or emigrated					Earners Invalid					Earners Unemployed					Total	Percentage of destitutes in Total Population of that occupation
			Adults					Adults					Adults				
	Infants	Children	Men	Women	Old persons	Infants	Children	Men	Women	Old persons	Infants	Children	Men	Women	Old persons		
Agriculture	0·07	0·20	0·01	0·14	0·02	0·01	0·08	0·06	0·04	0·03	0·02	0·08	0·07	0·04	0·03	0·90	0·75%
Agriculture and Labour	0·07	0·07	0·01	0·05	0·03	0·01	0·02	0·02	0·01	0·03	0·05	0·06	0·02	0·03	0·01	0·49	0·82%
Agricultural Labour	0·11	0·53	0·10	0·38	0·10	0·07	0·14	0·12	0·14	0·10	0·03	0·03	0·05	0·06	0·03	0·99	3·02%
Non-cultivating Owner	0·01	0·07	0·01	0·04	0·01	...	...	...	...	0·01	0·02	0·04	0·04	0·02	...	0·27	0·98%
All Agriculture	0·26	0·87	0·13	0·61	0·16	0·09	0·24	0·20	0·19	0·17	0·12	0·21	0·18	0·15	0·07	3·65	1·30%
Fishing	...	0·06	0·01	0·04	0·01	0·01	0·02	0·01	0·01	...	0·06	0·07	0·07	0·07	0·01	0·45	7·75%
Craft	0·02	0·17	0·05	0·12	0·03	...	0·05	0·03	0·01	0·01	0·01	0·01	0·02	0·02	0·01	0·56	2·70%
Food Industry	0·01	0·01	...	0·02	...	...	...	...	0·01	...	...	...	...	0·01	...	0·06	2·73%
Transport	...	0·01	...	...	...	0·01	0·01	0·01	0·01	...	...	0·01	0·01	0·01	...	0·08	7·06%
Trade	...	0·10	0·01	0·07	...	0·02	0·06	0·03	0·03	0·02	...	0·02	0·01	0·02	0·01	0·40	1·31%
Public Administration etc.	0·02	0·10	0·04	0·05	0·02	0·01	0·04	0·03	0·04	0·01	0·01	0·03	0·01	0·02	0·01	0·44	1·30%
Non-agricultural Labour	...	0·04	0·01	0·01	...	...	...	0·01	...	...	0·01	0·01	0·01	0·01	...	0·11	2·00%
Miscellaneous	...	...	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·03	0·01	0·03	...	...	...	0·14	1·83%
Unproductive	0·14	0·83	0·14	0·74	0·32	0·13	0·48	0·20	0·40	0·41	0·15	0·38	0·19	0·23	0·13	4·87	73·86%
Total	0·45	2·19	0·40	1·67	0·55	0·28	0·91	0·53	0·71	0·56	0·37	0·77	0·50	0·54	0·24	10·7[illegible]	3·39

The figures in the last column gives the percentage of the destitute families in each occupation as compared to the total number of families in such occupation. The figures in the other columns refer to actual numbers, in lakhs (hundred thousands).

It is obvious that such helpless women and children will be in an even more difficult position, among agricultural labourers. There are 38 thousand destitute women and 64 thousand children (including infants) without any earners. Another 35 thousand have invalid earners. Work will have to be found for all these women. The position is same with regard to non-agricultural labour, except that this group is much smaller both in the general population as also among destitutes.

The persons classed under "Food Industry" are almost all who live by hulling rice. This is universally an occupation of women, where country hullers are used. The figures for destitutes also bear this out. Many of these women are unattached persons who have been following this occupation to make a livelihood for themselves. The table shows that there are no children dependent on one large group of them who are invalid or unemployed. Others who have children dependent on them have been reduced to rely entirely on this occupation through death of earners and finally brought to destitution. In all the other occupations, the position of women who have lost earners is similar to that of agricultural

For the men formerly engaged in craft or trade a return to such occupations in the villages is not immediately possible except in some cases. These men made their living by serving the village agriculturists and when the agrarian economy was disorganised, these village servants were reduced to destitution. Most of them have lost their equipment, having sold them due to want or owing to inability to replace worn out tools. Rehabilitation of such artisans will necessitate supply of equipment as well as work. Such work may be in centres as well as in villages on an individual basis.

Weavers.—The case of only one group of artisans —handloom weavers—who stand on a different footing is considered in some detail. Their total number in 1940 was slightly less than 2 lakhs and they were responsible for 45 per cent of the cloth production in Bengal. Some of them worked on their own looms, while others were merely paid craftsmen using looms owned by *mahajans*. Even among those who work their own looms, the greater number receive advances of raw materials or even actual cash to meet their expenses on food and other essentials, and have to suffer through high prices

charged for yarn or low rate of wages (Bani or piece rate)[5]. In consequence "the weavers live from hand to mouth". The enquiry of the Government of Bengal from which these facts are quoted, revealed that "hardly 25 per cent are in a position to carry on production independent of the help and interference of the mahajans". The detailed notes on such famous cloth production centres such as Shantipur, Farasdanga and Rajbalhat, clearly bring out the wretched poverty of the weavers and their position of practically sweated wage servants to mahajans. The report indicates that the number of loomless weavers like landless labourers was on the increase even prior to 1940. The famine of 1943 accelerated this change, as it did in the case of agriculture. Many thousand weaver families sold or mortgaged their looms and gave up their family occupation owing to lack of means. If at present only yarn is supplied to weaving centres, the *mahajans* will reap most of the benefit. A proper scheme of rehabilitation must include (*a*) arrangements for restoring looms to the weavers who have parted with these under stress of necessity, (*b*) organising them into co-operatives in the larger centres, for purchase of yarn and sale of finished products, (*c*) relief grants to enable the weavers to live until they have woven enough clothes to earn a month's keep and (*d*) supply of yarn from Government Stores direct to weavers. Where co-operatives of genuine weavers (as apart from Mahajans) exist, the supply should be made through such organisations.

It is true attempts in the past to form co-operatives have not produced encouraging results. But there is now greater consciousness of their needs and possibilities of joint work among the weavers. With proper help from local welfare workers there is now a greater chance of success.

The weavers who can take their place in their old craft centres, should preferably be put back in those places. Some of these units may take the place of weaving work centres discussed later on under occupations for women destitutes. Isolated weavers who are homeless and cannot go back to their village may easily be absorbed in such work at other centres.

Unproductive.—It is to be noted that the occupational group marked 'Unproductive' is mainly of persons living on charity, *i.e.*, persons who had been reduced to destitution prior to 1943. The existence of a large number of such persons is merely an indication of the failure of the State to look after the economic well being of its people. Hence in any real planning for rehabilitation these persons should also be included and counted among those who need work.

Excluding the agriculturists proper, and the fishermen, whose cases have been discussed separately, we get the following figures for women and children (including infants) without earners, or with invalid earners or depending on unemployed earners:

(*Figures in thousands*)

	Infants	Children	Women	Men	Old persons
Earner Dead	38	193	149	38	52
Earner Invalid	26	81	66	46	62
Unemployed	29	62	43	36	20
Total	93	336	258	120	134

Of the adult men who are in the group linked to invalid earners, a large number are actual invalids. For the present we may leave out a good portion of them say one-fourth or one-fifth and take the number of men who may be available for work as 110 thousand. This will not be an underestimate, in view of the incidence of acute and ordinary sickness noted earlier.

Of this 110 thousand, probably 25-30 thousand will be partially absorbed in cultivation of land restored to women who have lost their earners[6]. Again, if occupation is provided to all the unemployed men, they will be able to look after a certain proportion of the women and children who are destitutes as being members of their family unit. Full occupation will therefore have to be found for at least 80 thousand men, for 15 thousand women whose earners will continue to be invalids and 149 thousand women whose earners are dead.

Occupations.—The only way in which useful work can be given to any person in society is through making him or her produce goods which are needed, or services. In a note on the rehabilitation of destitutes, a discussion of the meaning of the term "services" for gifted individuals is irrelevant. Here we have to consider only such humble services as these persons may contribute after a little training. Occupations like cultivation, or agricultural labour or fishing have already been discussed and are now left out.

A fair proportion of the able-bodied men may be given the useful occupation of constructing normal durable huts (not temporary shelters) for the destitutes. Each hut will cost about Rs. 20-25 in materials and will require 30 men × days of labour. It may be noted that the 3 lakh huts needed can

[5] Handloom cotton weaving in Bengal, *Govt. of Bengal Dept. of Industries Bulletin* No. 88, Alipore, 1941.

[6] About 22 thousand families of agriculturists and of the group agriculture and labour have lost earners, leaving behind women and children.

give occupation to 25 thousand persons over a year. Some of these may be women helpers as noted later. Only the cost of materials may be recovered later on over a number of years.

A much larger number can be employed in (*a*) excavating and cleaning silted up tanks, water sheds, canals and small streams, (*b*) putting up embankments to protect land against flood, (*c*) carrying out drainage projects. In view of the large amount of such work so far not taken up by the State, it is likely that a portion of the programme will absorb the remaining 60-65 thousand men. Such work can be carried out from November to June. During the four months of rain and autumn a very large proportion of the men can be employed in mosquito control work in the entire rural area, except those which are regularly inundated during this season. In these last mentioned areas, the work may start later. As there are 90 thousand villages in Bengal, mosquito control work can absorb the entire number of destitute able bodied men during the season, and leave a deficit. The agricultural operations reach a peak during July, August for transplanting and again in September (approximately) for a fortnight for harvesting the *Aus* paddy. There will therefore be an additional demand for men during these periods. The regulation of water ways will not only help to increase the crop production but improve the general health. Mosquito control work taken up in conjunction with such projects will stamp out malaria which is the cause of 80 per cent of sickness among the ill-fed villagers.

Boat building and water transport. The Government have already started constructing several thousand boats of somewhat inferior materials. Now that the demands of the war are at an end, this programme can be amplified and better materials used. Incidentially the large volume of military transport by water which required employment of many seamen, can be replaced by coastal trading in seaworthy vessels built in India. Only skilled workmen will be absorbed for such work. This will be helpful to artisans and also to technically trained men now losing their jobs.

Many of the rural areas in Bengal are still roadless. Amenities of education and sanitation, of relief and medical help are often made extremely difficult by the isolation imposed by lack of roads. Great difficulties were experienced by our surveyors in reaching many areas of Eastern Bengal and some parts of Northern and Central Bengal, in spite of the fact that most of them are rural people experienced in rural welfare work. A well planned road development scheme to link up rural areas with all weather roads to the administrative industrial and educational centres can furnish employment to thousands of labourers all over Bengal. Men as well as women can find work in such projects.

Keeping poultry, cattle or pigs. Poultry may be usefully kept in Muhammadan villages but pigs will be taken only among tribal folk. In view of the shortage of cattle, suggestions for building up dairies are meaningless at present. Such plans will have to be given effect to over a longer term. Importation of good milk yielding goats and goat breeding may however be taken up immediately as a cheaper and easier proposition.

Bee keeping is a subsidiary occupation suitable for old men. They may also help as herders of domestic animals, mentioned in the previous paragraph.

This leaves us about 164 thousand women to be provided with means of livelihood for themselves and for 2 children (and infants) on an average. The ratio of women to children, stated, can be confirmed by a simple calculation. Since a destitute family, has on an average 3·1 members, the 110 thousand men given jobs will be linked to and looking after at most 231 thousand women and children. But there are 429 thousand children and 258 thousand women destitutes. Subtraction of 231 thousand proportionately from these two figures leads to a close confirmation of the conclusions already drawn.

It is probable that a portion of these women were last year engaged in road construction for military purposes. Others again, sold their honour for food and clothing for themselves and their children. Reports from surveyors from the Chittagong area in 1944 and later surveys by others (including some trained men) indicate that this has happened on a large scale in that area. The bumper crop at the end of 1943, and the good harvest of 1944 enabled many of these destitute persons to manage to live on help given by others. The poor yield in 1945 to be anticipated from the present abnormal rainfall in different parts of Bengal, will wipe out the little reserve that the good yields of the two previous years have given, and the number of destitutes will increase again, unless early steps are taken. The problem will in fact be more acute in one respect in 1945 than in 1943. Due to the end of the war a large number of workmen in jute mills, in war industries and technical jobs, as well as many of the genteel poor in the different supply offices, will be thrown out of work. With proper planning, and less strain on the transport system, the distribution of relief may work better than in 1943; but even a smaller shortage of grain will lead early next year to greater distress. The destitute women and children who have managed to survive through 1944-45 will in any case, again face starvation, unless work is provided now.

Occupations for Women

Husking paddy.—This is not a paying occupation. Only women without dependents can make a living by it. Apart from those who were previously following this occupation and became destitutes, a certain number of women will be able to take it up. Centres may be organised or hullers supplied to houses, according to local conditions. These women may make a living if licenses to new rice mills are not issued, and a guaranteed wage paid. Such living wages will bring the expenses above that paid to rice mills. This difference will have to be met by the State out of the price charged for rationed food grain.

Grinding wheat or pulse.—This can only be a subsidiary occupation for women who have some other source of income as from land (where the land has to be cultivated with the help of others).

Spinning and weaving.—Spinning is an occupation which can be taken up by old men as well as by women. They can also arrange to increase their out-put by taking the help of children above the age of 9 or 10 to some extent. So long as the present mismanagement of distribution of cloth from mills and country looms and the shortage of yarn continues, there will be no difficulty in the matter of sale. The price fixed by Khadi shops will not however be realised if large scale production takes place. A bare living may however be possible for a women by spinning 9 hours a day and a child above 10 years doing it for about 4 hours. Guaranteed higher wages will be needed here to enable better living conditions and to reduce such work by women to 8 hours a day and by children to about 3 hours. Assuming that an adult spinner can produce 3 thousand 2 hundred yards of yarn in 8 hours and a child 6 hundred yards in 3 hours, the present guaranteed prices of the Khadi organisations will bring such a unit (one adult, one child) an income of Rs. 21/- approximately per month. It is assumed that rice will be rationed and not sell above Rs. 10/- per maund in the rural areas where such centres are situated, and hence this income will just suffice for the family[7].

The spinning centres can be run economically if the cotton needed is supplied after being ginned to ensure fairly uniform output of thread. The cloth should be woven at the centre or at a larger centre fed by several sub-centres. This in its turn should provide some occupation to destitute weavers. One woman working 8 hours a day and one child 3 hours a day can spin enough coarse thread for 6 dhuties or saries each month. As a weaver (helped by a woman in preparing the thread for warp, winding up the thread on bobbins for the woof, etc.) can finish about 18 dhuties in a month, the proportion of weavers (men) to women spinners and helpers, including children above 9 or 10 comes out as 1 to 7. We may also put it differently. Three centres for spinning each with 100 women and 100 children above 10 will meet the requirements of a weaving centre with 100 looms in charge of 100 weavers helped by 100 women. As Bengal does not produce enough clothes for the province, and for some years at least the cotton industry will not grow sufficiently to supply the entire needs, a fairly large number of such centres may be organised.

The cotton needed for it may be grown locally. The yield will be less than that in the black soil of Berar but enough good soil is available in most districts of Bengal for a moderate crop. The saving in the cost of transport will probably be found to make up for a good part of the loss in yield, per acre, as the entire amount should be planned to be consumed locally.

Shelters.— Women workers can help indirectly by preparing some of the materials needed for the huts, suggested earlier to be created for homeless destitutes.

(*a*) The hogla mats, and bamboo woven pieces (darmas) may be prepared by them.

(*b*) Where earthen walls are erected, the mud paste may be prepared by them, the men doing the harder work. They may also help in other similar subsidiary labour. In general carrying the material is done partly by women.

(*c*) Preparation of coir ropes from cocoanut fibre. With somewhat improved twisting machinery, this can be a profitable occupation. The occupation and the allied work of coir products is practised in all the districts of Southern Bengal, extending from Midnapore to Chittagong.

Health service.—Women may be trained to perform vaccination in villages, to stamp out small pox. They may also be given a good training in practical work as *dais* extending over several months. As this work is done in the villages by illiterate women who have only traditional ideas based on empiric knowledge as well as superstition, the results will certainly be better than before. In the interest of permanent welfare, such women should also be given an intensive course of education (on modern methods) in their mother tongue to make them literate. The entire period required for all this work will be less than one year. The expenses for the women and their dependents will have to be borne during the training period by the State.

Education.—This portion of the work belongs to long term planning. But arrangements have to

[7] Calculations based on current rates of payment by Khadi Pratisthan and similar organisations.

be made for teaching of the destitute children. The small number of educated men and women including teachers, who have been reduced to destitution may be provided in this way.

Organisation of centres.—Several different occupations have been mentioned as suitable for women, and centres have been suggested to be organised for them. The outline given for the spinning-cum-weaving centres is typical of what may be done. The larger centres may be organised at the same locality as the composite homes for women and children and the orphanages mentioned earlier. It has been estimated that 250 such institutions (Homes, etc.) will be required at first. Later on a number of women may set up house separately. This will not cause any difficulty if the work centres are linked to these places. The structures vacated may be usefully taken up later on to meet the needs of more developed crafts or as schools or health centres. If we have four sub-centres at about equal distance from a larger co-ordination centre organised along with the Homes or Orphanages, we shall have a total of 1,000 work centres besides 250 linked to the Homes and Orphanages. This means, on an average (not actual) 12 work centres per sub-division. For an area like Tamluk, the distances between work centres will be 3 miles. This distance can be comfortably covered daily for work at the centre, as each person will have only 1½ miles to walk on each journey. The average will be about 2 miles, as some will travel only half a mile or less each way.

Expenses.—A very rough estimate of expenses is given below:

Restoration of one acre of land on an average to 25 thousand families, @ Rs. 500/- per acre plus equipment @ Rs. 100/- per family—Rs. 150/- lakhs. Restoration of one-third acre of land on an average for 14 thousand families and Rs. 100/- for equipment for every three families—Rs. 28 lakhs. One boat and other equipment for 11 thousand fisher families @ Rs. 150/- per family—Rs. 16 lakhs approximately. One hut per family for 3 lakh families of destitutes @ Rs. 50/- per hut (Rs. 25/- for materials and Rs. 25/- for labour) in rural areas —Rs. 150/- lakhs. It is possible that out of 25,000 persons needed for this work only a certain proportion will be available from among destitutes. The rest will have to drawn from the unemployed among the semi-destitute group.

One thousand work centres—The Government estimate is Rs. 2,000/- capital expenditure on building and Rs. 500/- on equipment. The working capital needed for each centre of 100 workers is estimated as Rs. 2,000/-. The capital outlay will therefore be Rs. 25 lakhs and the working capital—Rs. 20 lakhs. The worker's wages at -/8/- annas per day will be Rs. 15 lakhs per month. We may reserve two months wages as dole to cover sickness, *i.e.*, Rs. 30 lakhs.

To guarantee living wages a small portion of it may have to come as subsidy, or to meet the marketing charges. The staff needed will be something like this:—

		Rs.	
Sub-Centres—	One Superintendent & Storekeeper	70	p.m.
	Two artisans or instructors @ ...	40	,,
	One ordinary teacher	40	,,
	Total ...	190	,,
	One Darwan	20	,,
	Total ..	210	,,
Main Centre—	Superintendent	70	p.m.
	Clerk & Storekeeper	60	,,
	Artisan etc.	80	,,
	One teacher	40	,,
	Two Darwans	40	,,
	Total . .	290	,,

For a unit consisting of one main and four sub-centres we shall have to spend about Rs. 1,130/- or roughly 1,200/- per month. For a total of 250 such units the expenses will be Rs. 36 lakhs per annum.

250 Homes and Orphanages—Of these 125 will be permanent orphanages in charge of matrons and will run for some years. Each will have 100 inmates. The capital expenses and equipment will probably be Rs. 2,000/- per home, *i.e.*, Rs. 2·5 lakhs. The running cost, including food @ Rs. 10/- per head (an underestimate) and clothing @ Re. 1/- per head per month and a matron, a cook and a darwan will be Rs. 18 lakhs.

For the temporary Homes, the capital expenses will be double as they will house an equal number of women and children. When vacated the bulidings will be available for advanced training courses, for industrial work as well as for higher types of schools.

Calculating at the same rate the capital outlay will be Rs. 5 lakhs. These women will need some help for at least a month for their own livelihood. Probably, it will take three months on an average before they can earn cough to support their children. This is a rough guess. The total cost for this period will be about Rs. 10 lakhs.

The cost of services—It has been suggested that 80 thousand men are to be put on excavation, embankment, and road building work, besides construction of huts. The expense on materials for mosquito control will not be calculated as it will save expense on medical relief. The other works will also eventually bring returns in better crops, less flood and more amenities. But the present cost may be calculated for 12 months work in the year to include

both kinds of occupation. If we assume that 15 thousand destitute men are absorbed in hut buildings, the cost for the other work will be @ -/8/- per day —Rs. 117 lakhs. Regarding midwives, also the expense of training for one year will have to be counted. If for 90 thousand villages of Bengal, we train even 15 thousand midwives, the cost will be about Rs. 30 lakhs for food and clothing and Rs. 5 lakhs for general education and training as suggested.

Medical Relief.—Hospital treatment of 10 thousand persons for 3 months will cost Rs. 20/- per head, per month in overhead charges (doctor, nurse, house rent, servants) and Rs. 40/- in food and medicine. The total will be Rs. 18 lakhs. This excludes the cost of equipment which will be not less than Rs. 4 lakhs. The medical units will cost a little over Rs. 10 lakhs. Doles to 90 thousand invalids for three months @ Rs. 10/- per month—Rs. 27 lakhs. These expenses which are definitely an underestimate come to a total of about rupees seven crores excluding milk for infants and old age pensions for aged persons. The actual figures may come to Rs. 10 crores but it should be remembered that in the war much larger sums of money have been spent each month even by India. The total required is not therefore too high or not possible to raise, to fight destitution with success.

The Government budget provides about four crores for Rehabilitation. This means about Rs. 37/- per destitute—for complete restoration of economic self-sufficiency, or in terms of the family unit, Rs. 111/- per family. There is reason to believe that the officials have not been able to organise Rehabilitation even to this extent. This is not surprising as reports are received from fishing villages that they cannot get interest free loans for equipment, or if they get advances, no relief grant is made for maintenance until fishing brings an income. No attempt has also been made to restore land to agriculturists, in an organised manner. The handicaps in the way of recovery of land by the destitute or semi-destitute agriculturist have proved too formidable for him to take initiative in this matter. Similar reports are also coming from weaving centres of failure to cater to the real need of the poor. The actual power of carrying out the rehabilitation measures rest with local officials, in each areas. They find it difficult to unbend, and co-operate with the people directly.

It should however be remembered that even this budget of ten crores or these organisations will not provide a permanent solution of the problem. That will be possible only on a long term planning for production of more food and clothing and services for the country as a whole and arrangement for an equitable distribution of the same. It is also essential to reduce the pressure on land by industrialisation. A brief reference to the same has been made in my earlier article on "The Problem of Rehabilitation". (SCIENCE AND CULTURE—July, 1945).

ENGINEERING RESEARCH IN SWEDEN

THE position of engineering research in Sweden has been vividly described by Professor Edy Velander, Director of the Royal Swedish Institute for Engineering Research, in a recent issue of *Engineering* (March 3, 1945). According to him, engineering research in Sweden is mainly grouped around the three corners of a triangle, represented by engineering colleges, independent research institutions and industrial laboratories. The Royal Institute for Engineering Research or *Ingeniors Vetenskaps Akademien*, commonly known as the I. V. A., established in 1919, is a learned society and an industrial foundation for the development of the country's national resources and for the promotion of industry through research The initiative taken by Great Britain soon after the last war to stimulate research aroused great interest in Sweden, and when Government and industry agreed to create the I. V. A. their plans were strongly influenced by the ideas leading to the eastablishment in Great Britain of the Department of Scientific and Industrial Research and its branch Research Associations. The I. V. A. is maintained from approximately equal sources of income from (*i*) the proceeds from an industrial donation of about £85,000 dating from 1919, (*ii*) certain annual subsidies from an industrial association for the promotion of research, and (*iii*) annual State grants.

The I.V.A. has ten departments *viz.*, (1) Mechanical, Shipbuilding, Aeronautical and Thermal-Technology ; (2) Electro-technology ; (3) Building, (4) Chemical Technology; (5) Mining ; (6) Production and Factory Technology ; (7) the Basic and Ancillary Sciences Relating to Technology ; (8) Arboricultural and Wood Technology ; (9) Economic Sciences and Organization ; and (10) Biotechnical and Related Sciences. In 1943 a Fuel Research Station was built

by the State and placed at the disposal of the Institute. Of all the research and works group, the Technical Research Organization (or the F.B.O., as it is commonly termed) represents probably the most unique type of a giant informal committee founded in 1939, which has no parallel in any research organization of other countries.

The characteristic feature of the F. B. O. is a group of some 250 "contact men" who have made their services available for co-operative tasks. Every contact man represents a certain group of his colleagues in the field of applied scientific research, for example, an industrial laboratory or research institution, a technical college or university institution, a State bureau, an association or a learned society of a technical committee. The main purpose of the contact men is to transmit questions and information from one group to the other. They are not always selected from among the leading figures but may frequently be young men who have the time and interest necessary to take charge of such contact work. A small nucleus of central contact men forms a central unit with its own chairman and holds regular conferences. In order to promote friendly co-operation in research circles the F.B.O. from time to time arranges large meetings, study visits and a series of conferences on research methods to bring the varied branches of knowledge of the different subjects together.

The ever-increasing understanding of the importance of research following the last war resulted in the formulation of a Committee, in the spring of 1938, to investigate the most efficient manner of scientific research. The Committee was formed by the Federation of Swedish Industries with the close co-operation of the I.V.A., which, ultimately through the Swedish Government, decided in August 1940 to appoint a Commission of seven experts to study the organization of scientific investigation, while at the same time another Commission was appointed to deal with the problem of higher technical training. The research Commission has since proposed that every year a large sum should be made available for research programmes to an amount which should gradually be brought up to the million mark or more. For the budget year 1943-44, the sum is 700,000 Krones (roughly £ 38,500). The Commission also recommended the establishment of a State Research Council on which the I.V.A., the Royal Academy of Sciences, the technical colleges and the Engineers' Association would be represented. The Technical Research Council started its activities in 1942 with proposals to establish council for agriculture and medicine.

The Commission primarily studied wood and building research. Wood research is of great national importance to Sweden to such an extent that the existing Wood Chemistry Institute at the Stockholm Royal Technical College, the Central Laboratories for the Cellulose Industries and the Swedish State Testing Office were inadequate. The Commission, therefore, proposed the establishment of a Swedish Wood Research Institute in Stockholm which was to be built in 1944 at a cost of about £120,000.

The second largest field is building research which, however, presents a different aspect. In this case there are a number of laboratories fairly well equipped as well as State and private organizations devoted to the improvements in building construction methods. As, however, there is no proper co-ordination between these different enterprises, it has been proposed to establish a pool for co-ordinating these various organizations, instead of founding a separate institute.

In 1941, the cement industry established a generous fund making it possible to build and equip a Central Institute for Cement and Concrete Research.

For a good many years the iron and steel industry has had an organization called the *Jernkontoret* (Swedish Iron Masters' Association) which has also a research division. Under the auspices of that organization, a Metallographic Institute was established some years ago. It has now been decided to enlarge and reorganize that Institute in co-operation with the non-ferrous metal industry and the Federation of Mechanical Industries. Likewise a small Institute for Geotechnical Research has been established in co-operation with the State Railway Administration, the Road Authority and other official interests.

The Research Commission has also proposed a Textile Research Institute as a parallel to the wood and metal institutes and located at Goteborg near the Chalmers College of Technology. This Institute is to be equipped with the remarkable apparatus developed by the Svedberg and Tiselius for the study of large molecules.

The proposal of a Food Conservation Research Institute to work in collaboration with the division of physical chemistry at the Textile Research Institute is also being investigated.

The Leather Research Institute has been established by some interested industries for the purpose of co-operating with the State, and a small institute for brick and clay research is also planned. There two institutes may be eventually housed in the future extensions of the I.V.A.

Regarding the Commission's work on higher technical education, matters connected with applied scientific documentation, such as organization of libraries and statistical services, are receiving close attention.

All these plans given herein have not yet been

fully tried out in practice, and more experience will be available within a year or two now when the hostilities have ceased. However, as the whole idea is characteristic of the rapid development in the field of research now taking place in Sweden and of the desire to establish a close co-operation between State and industry in a fair and just basis, it is thought that this brief account will not fail to arouse interest of research workers in India as well, as this country also is now on the verge of rapid progress wherein engineering development will play a conspicuous part in moulding the final patterns of industry.

S. K. Ghaswala.

GOVERNMENT RECOGNITION OF THE "NATIONAL INSTITUTE OF SCIENCES OF INDIA"

SCIENTISTS all over India will be glad at the recent Press Communique that the Government of India has recognized the National Institute of Sciences as the premier scientific association in India. The story of its foundation may briefly be told:

The annual meetings of the Indian Science Congress had been the only common meeting ground of Indian scientists (for over twenty years) prior to 1934. But though it did an enormous amount of service in bringing scientists from all parts of India together, it was a peripatetic body, whose activities lasted only for a week, and was transient. It was felt, however, that if a senior body of scientists could be organized having a status and functions similar to those enjoyed by the Royal Society it would materially promote the cause of science in India. This point of view was stressed in the presidential address of Prof. M. N. Saha in the 21st session of the Indian Science Congress held at Bombay in 1934. On his suggestion, the Indian Science Congress appointed a Committee of 40 representative scientists from all parts of India with Profs. M. N. Saha and S. P. Agharkar as organizing secretaries. This Committee, called Academic Committee had a large number of sittings which were generally presided over by Sir Lewis Fermor, F.R.S. who was then Director, Geological Survey and had been an ex-President of the Indian Science Congress. The subsequent course of events were not, however, smooth, but it is needless to call attention to the controversies which raged over this question in 1935. But as a result of one year's continuous deliberations, meetings and conferences and compromises, it was agreed that a society of senior scientists should be founded under the designation, 'The National Institute of Sciences', with headquarters to be temporarily located at Calcutta, and all other Indian scientific academies and societies agreed to co-operate with this association.

National Institute of Sciences of India

The National Institute of Sciences of India was formally founded on the 7th January 1935, at a meeting held in the Senate House of the Calcutta University under the chairmanship of Dr J. H. Hutton, President, Indian Science Congress.

The purposes for which the National Institute was founded were: —

(*a*) The promotion of natural knowledge in India including its practical application to problems of national welfare.

(*b*) To effect co-ordination between scientific academies, societies, institutions and Govment scientific departments and services.

(*c*) To act as a body of scientists of eminence for the promotion and safeguarding of the interests of scientists in India: and to represent internationally the scientific work of India.

(*d*) To act through properly constituted National Committees in which other learned academies and societies will be associated, as the National Research Council of India, for undertaking such scientific work of national and international importance as the Council may be called upon to perform by the public and by Government.

(*e*) To publish such proceedings, journals, memoirs and transactions, and other publications as may be found desirable.

(*f*) To promote and maintain a liaison between Science and Letters.

(*g*) To secure and manage funds and endowments for the promotion of Science.

(*h*) To do and perform all other acts, matters, and things that may assist in, conduce to,

or be necessary for the fulfilment of the above-mentioned aims and objects of the Institute.

Membership consists of Ordinary Fellows and Honorary Fellows. The Institute started with 124 Foundation Fellows on its rolls, elected according to the scheme prepared by the Academy Committee. An election is held every year for the enrolment of new Fellows, by ballot. 26 Ordinary Fellows and 7 Honorary Fellows were elected in the first year, and since then ten Ordinary Fellows and four Honorary Fellows are elected annually. Recently, the number of fellows to be elected annually has been raised to fifteen. The membership in December, 1944, numbered to a little over two hundred.

The administration and management of the affairs of the Institute is entrusted to a Council composed of the officers of the Institute—namely a President, two Vice-Presidents, a Treasurer, two Secretaries, a Foreign Secretary and other Members of Council to make up a total of 25. In addition, the Royal Asiatic Society of Bengal, the National Academy of Sciences, India, Allahabad, and the Indian Academy of Sciences, as co-operating Academies, and the Indian Science Congress Association each nominate an Additional Vice-President and one Additional Member of Council from the Fellows of the Institute. The Government of India nominate a representative on the Council from among the Fellows of the Institute.

The Institute issues the following publications. The *Proceedings*, of which one volume is published each year, contains (1) Symposia, (2) the shorter papers on various scientific subjects read before the meetings of the Institute, (3) the President's Address, (4) Minutes of the Annual General Meetings and Ordinary General Meetings, (5) Annual Report, and (6) other business matters.

The Institute also publishes *Indian Science Abstracts*, which consists of an Annotated Bibliography of Science in India.

The office of the National Institute of Sciences of India is at present located on the ground floor of the premises of the Royal Asiatic Society of Bengal, 1, Park Street, Calcutta.

Reviewing the activities of the National Institute of Sciences and other scientific societies in India Prof. A. V. Hill makes the following remarks in his pamphlet "Scientific Research in India".

"The development of science in every country depends very much on the familiar association of scientific men in the activities of scientific societies. These are the common meeting grounds at which ideas are ventilated and criticised, new facts discussed, common policy decided and people get to know each other. The progress of science in the United Kingdom has been intimately bound up with the development of its many learned societies, starting with the Royal Society in 1662.

We are fortunate in Great Britain in having in the colleges of the older universities, in some of the senior common rooms of the newer ones, in various clubs and in many other such associations a means of bringing scientific men and scholars into close and familiar contact with one another. There are fewer opportunities for such contacts in India. It is all the more important therefore that scientific societies should be fostered and encouraged."

Scientific societies are of two kinds, general and special, with memberships drawn respectively from the whole of science or from a single branch of it. Both kinds have an important part to play in the publication of scientific papers and results, and through their libraries and collections—in providing repositories of scientific information. Scarcely less important is their influence in making living communities out of a number of people always critical and often highly individualistic. In India where so many causes tend at present to separate individuals, groups and communities from one another a strong common interest in science as a whole, or in some branch of it, could have as a bye-product an important influence in keeping people working sensibly together.

The oldest learned society is the Royal Asiatic Society of Bengal, originally the Asiatick Society, which was founded by Sir William Jones in Calcutta in 1784. From its activities has sprung by far the larger part of subsequent scientific activity in India, not to mention all its own work for literature, history, archaeology and philology. It may be regarded as the mother of the Indian Science Congress Association which held its first meeting in 1914, and the grandmother of the National Institute of Sciences of India established in 1935. The Indian Science Congress Association has taken already a great place in Indian scientific activity: it is the opposite number of the British Association for the Advancement of Science. Besides the National Institute of Sciences, *which is the nearest equivalent in India of the Royal Society*, there are two other general scientific Academies claiming national scope:

(*a*) the United Provinces Academy of Sciences founded in 1930 at Allahabad, which was intended primarily to cater for all branches of science in Northern India; it was renamed the National Academy of Sciences, India, in 1936; and

(*b*) the Indian Academy of Science founded at Bangalore in 1934.

Of these three, the body best suited by constitution and membership to assume the role of a national academy of science, such as, the Royal

Society (London), the Royal Swedish Academy of Science (Stockholm), the Royal Danish Academy of Science (Copenhagen), the Academy of Science of the U. S. S. R. (Moscow), etc., is the National Institute of Sciences of India. It is oddly named for such a body but that was due to a compromise which was necessary at the time it was founded. Its present headquarters are in the rooms of the Royal Asiatic Society of Bengal in Calcutta, but it has decided, when possible, to transfer its headquarters to Delhi. It hopes, as time goes on, to take over in India more and more of the functions which are discharged by national academies of science in other countries.

The National Institute of Sciences was invited last winter by the Royal Society to send representatives to London for the discussion of such matters and to concert joint plans for the co-operation of the scientific societies of India and of the United Kingdom. Among plans to be discussed will be those for the Imperial Scientific Conference to be held soon after the war is over, possibly in the summer of 1945. The time is coming when India will be an independent unit of the British Commonwealth: with science as important as it will be in the world of tomorrow it will be essential for Indian science as a whole to have some strong independent national scientific body to represent it both to the Government of India and in relation to the science of the rest of the world. It is hoped, therefore, by the National Institute of Sciences that some formal recogntiion may be given to its position by the Government, for example by a Royal Charter such as the Royal Society and the British Academy have. Few things could do more to stabilize the position of science in India, or its relations with science in the rest of the Commonwealth, than to have a strong and effective national academy of science, independent of the Government but recognized by the Government.

There are now specialist national societies in India in most scientific subjects, *e.g.* in Geology (1906), Mathematics (1907), Botany (1921), Chemistry (1924), Physics (1934), Soil Science (1934) and Physiology (1934). Some of these are of nation-wide membership and scope, others have as yet only small membership and influence. Most of them were started by the initiative of scientists in Calcutta, and some have not yet been properly supported in other parts of India. It is not yet sufficiently appreciated that the status of a corresponding society, if, for example, physiologists throughout India complain of the little regard paid to their subject, they should join and support, and take joint action through the Indian Physiological Society.

All these scientific societies are a product of the independent activities and keenness of scientists themselves. They cannot be a direct concern of the Government. The Government, however, could assist and encourage them in various ways which would not diminish their independence. For example:

(*a*) they could be invited to appoint representatives on government advisory committees or boards;

(*b*) they could be invited to institute special inquiries, to collect information, or to advise, on matters of national importance;

(*c*) grants could be made to assist their scientific publications; these could be allotted by the National Institute of Sciences as corresponding grants in the United Kingdom are by the Royal Society;

(*d*) a Government Grant-in-aid for Scientific Investigation, and another for International scientific conferences could be put at the disposal of the National Institute of Sciences for distribution, as is done by H. M. Government in the United Kingdom to the Royal Society;

(*e*) universities and other employers could be advised that attendance, with reasonable limits, at meetings of scientific societies may be regarded as among the normal duties of scientific men;

(*f*) financial assistance could be given to their libraries and museums, and towards the expenses of delegates to meetings in India or abroad.

In this connection, a proposal has been made by Sir Henry Tizard that, in lieu of government subsidies to air lines, the Government might purchase a certain mileage of air travel and allot it for distribution to such bodies as scientific societies. This would certainly help to 'mix scientists up'.

The expenditure involved in such grants or assistance would be small, but would produce an effect altogether out of proportion to its extent. It would be natural for the National Institute of Sciences to take up such matters with the Government, on behalf of its sister societies.

Since Prof. Hill's report was submitted to the Government of India we understand that the National Institute of Sciences has been in communication with the Government of India for the transfer of its headquarters to Delhi as is the case with National Academies of all countries. It has agreed to remove to Delhi on condition, (1) that the Government should provide the National Institute of Sciences with a suitable office at Delhi and with suitable

buildings as early as possible, (2) that it should grant the National Institute of Sciences a sum of money for defraying the travelling expenses of the members of the Council for three meetings and also towards publication of its journals, symposia, etc. and for founding a number of national research fellowships, (3) that it should give it recognition as the premier scientific organization in India.

The Press Communiqué indicates probably that the Government of India has accepted all the conditions. It is hoped that the advice of National Institute of Sciences will be sought by the Government of India in all matters of scientific research and organizations, and it will play a distinguished role in the public life of India such as has been played by the Royal Society of London in the United Kingdom.

Notes and News

SCIENCE IN DENMARK AND NORWAY

ACCORDING to a report of *the Times*, London, Professor A. V. Hill recently visited Denmark and Norway as a delegate of the Royal Society 'to bear its greetings, to present to the academies of the two countries copies of all that the Royal Society has published since 1940, and to request the academies to be instrumental in distributing to scientific workers of their respective countries certain sums of money from a fund founded, in memory of Sir Horace, Darwin, for the purchase of scientific instruments'.

In Denmark, Prof. Hill was pleased to find that science had not suffered as badly as in most countries of Europe during Nazi occupation. Up till the autumn of 1943, the Germans treated the Danes with best behaviour, but since then insisted on co-operation of the Danish scientists with the Third Reich. For lack of this co-operation, Prof. Rehberg, the zoologist, and many other men of science became victims of Nazi oppression. The Germans, however, did not destroy the laboratories, nor did they interfere with the research work, and excellent papers have been published in the *Proceedings* of the Academy. It appears that the normal scientific activities have been restored in Denmark; for they are now planning to organize next year an expedition for marine biological investigation off the coast of Africa, for which they have already procured a ship and funds. Their chief scientific need is book and journals.

Norway, on the other hand, had a different tale to tell. The president of the academy, Prof. Bull, passed three years in a concentration camp. The laboratories were stripped of apparatus and the departments closed, so that little scientific work could be carried out in Norway during the war. The extent of dislocation of scientific life suffered there will be realized from the fact that Norway is now finding it difficult to start higher scientific training. She is now keen on getting medical instruction under way as soon as possible and has made arrangement with Denmark and England for the training of medical students in those countries. Similar arrangement for overseas training in other sciences is now under consideration.

FERTILIZER RESOURCES OF THE U.S.S.R.

AN article by Virginia Kinnard in *The Foreign Courier and Weekly*, abstracted in *The Chemical Age*, July 28, 1945, gives a fairly detailed account of fertilizer developments in the U. S. S. R. In phosphatic fertilizers, Soviet Russia now occupies a leading position in Europe. Her newly discovered phosphorite deposits in the Kara-Tau area, described as one of the richest of world's known deposits, have been estimated at more than one billion tons at accessible depths.

Before World War I, phosphate rock for home consumption came in small quantities from the mines of Podolia in Ukraine and of Bessarabia. Rich deposits of appatite were later discovered at Khibiny in the Kola peninsula and served as the principal source of fertilizer in U. S. S. R. for a considerable length of time.

In 1936, deposits of phosphate rock were discovered in the Kara-Tau range in the Dzhambul Oblast in Southern Kazakhstan. The deposits extend in a narrow line for more than 60 miles, probably in thick, continuous seams with an average thickness of from 33 to 38 feet. A year later this was followed by the location of another extensive deposits of high-grade stratified phosphorites in the North-Western part of the Kara-Tau range in the

basin of the Kok-su and Uch-Bas rivers. The Kok-su deposits contain about 28 to 32 per cent of the phosphoric anhydride and has a very low proportion of iron and aluminium—not more than 2 to 2·5 per cent. Since then several new deposits have been explored in this area, and more than 350 deposits, divided into 45 separate mining sections, are now known to exist, with an estimated reserve exceeding one billion tons.

Such intensive search for deposits of phosphatic rocks and other chemical fertilizers followed the reorganization of Soviet agriculture on modern scientific basis. Need for increasing artificially the fertility of highly impoverished soils and for bringing more land under the plough to support a growing population on a better standard of living created an unprecedented demand for chemical fertilizers. It is reported that in 1928 Soviet Union consumed 300,300 tons of chemical fertilizers, 676,800 tons in 1930, and about 1,139,300 tons in 1932. Consumption of phosphate rock increased from 7,000 tons in 1925 to more than 1,000,000 tons in 1938. The consumption figures, in metric tons, for nitrates, superphosphates, ground phosphate rock, and potash salts in 1913 and in 1936 were as follows: nitrates—20,000, 477,000; superphosphates –230,000, 1,481,000; ground phosphate rock—9,000, 577,000; and potash salts—25,000, 445,000. Such increased use of fertilizers has resulted in a much higher yield of crops. Thus yield of cotton has increased by more than 350 per cent and that of grain from 50 to 70 per cent. Apart from greatly promoting agricultural economy in the Soviet Union, fertilizer developments have led to the establishment of a number of important chemical industries of inestimable value in a programme of nation-wide regeneration.

DELEGATION OF INDIAN CHEMICAL MANUFACTURERS

A delegation of Indian Chemical Manufacturers and experts, headed by Dr K. A. Hamied, is proceeding to U. K. and U. S. A. on behalf of the Indian Chemical Manufacturers' Association. The delegation is non-official in character like the Industrial Delegation which has just returned. It will study the development of the chemical industries in those countries during the last decade and also the working of the scientific industrial research institutions. The Association has in view the establishment in this country of a first-class research organization for the benefit of the chemical industry on the basis of the delegation's new experience in U. K. and U. S. A. Another purpose is to explore the possibilities of a healthy co-operation between chemical and pharmaceutical industries in India and of the countries it has now proceeded to visit. In a statement to the Press on the eve of departure of the delegation, Dr Hamied expressed his optimism with regard to this co-operation in the following words, "I feel that a spirit of co-operation between India's chemical industries and the chemical manufacturers and scientific workers in the highly industrialized countries like the U. K. and the U. S. A. can greatly contribute in the future development of chemical industries in this country." Rightly so. But will this co-operation be forthcoming? We have great doubts whether the U. K. and the U. S. A. have any intention to contribute to 'the future development of chemical industries in this country'.

ROYAL INSTITUTE OF SCIENCE

THE Royal Institute of Science, Bombay, will be celebrating its Silver Jubilee in the third week of November this year. His Excellency the Governor of Bombay will inaugurate the celebrations on November 15, 1945, which will continue up to November 22.

The Institute of Science was formally opened on March 27, 1924. Its foundation was, however, laid several years ago by Sir George Clarke, later known as Lord Sydenham, on April 5, 1911. During the visit to India of His Majesty the King Emperor, the Institute received royal recognition and came to be known as the 'Royal Institute of Science'. The actual teaching work was started in 1920.

The Institute is a Government institution under the Control of the Director of Public Instructions. It is affiliated to the Bombay University for B.Sc., M.Sc. and Ph.D. teaching and is assisted by an Advisory Committee consisting of the Vice-Chancellor of the Bombay University, representatives of the University, industry and colleges, donors, and nominees of Government.

The policy of the Institute is (*i*) to interest the public in science, (*ii*) to teach science to the undergraduates, and (*iii*) to provide facilities for research to the staff and post-graduate students of the Institute, and to other workers not directly connected with the Institute. It also co-operates with other scientific institutions engaged in research work and assists industry by elucidating their immediate and long-range problems. These aims are achieved with the assistance of the staff and students of the Institute, and with the co-operation of some of the distinguished scientists in Bombay who are appointed as Honorary Professors at the Institute. These men have been the Directors of the Meteorological Observatory at Colaba, the Industrial Chemists to the Government of Bombay, the Director of Fisheries

to the Government of Bombay, and the Chief Assayer at H. M.'s Mint, Bombay.

The Institute primarily aims at research in mathematics, physics, chemistry, botany and zoology. Some of the investigations tackled in the Institute are the manufacture of potassium chloride and bromine from sea-bitterns, magnesium carbonate, strontium carbonate, potassium chlorate, hydrogen peroxide, gelatin, potash from food-ashes, extra-pure and analytical-quality chemicals, titania from bauxite-sludge, chloramine-T, saccharine, photographic sensitive materials, etc. For these investigations, the Institute has received research studentships and other financial assistance from persons connected with Industry, University, the Council of Scientific and Industrial Research, the Imperial Council of Agricultural Research, etc.

The Institute possesses a good library of scientific literature. For the education of the public in scientific matters, the Institute organizes science exhibitions and popular scientific lectures.

SERGEI VAVILOV: NEW PRESIDENT OF THE U.S.S.R. ACADEMY OF SCIENCES

We have much pleasure to inform our readers that Academician Sergei Vavilov was elected the new President of the Academy of Sciences of the U. S. S. R. on July 17, 1945 in succession to Academician Vladimir Komarov.

Born in Moscow in 1891, Vavilov graduated from Moscow University in 1914. He began his research work, while still a student, under the guidance of the famous Russian physicist, Lebedev. In protest against the reactionary policy of Kasso, the Tsar's Minister of Education, Vavilov refused to continue his studies at the University, to prepare himself for a teaching career. According to the law of that time, he was therefore called to the colours. In 1918 he began teaching, first as assistant professor of physics at the Moscow Higher Technical School, and since 1920 as professor. At the same time he lectured at the Moscow University. In 1930 the Academy of Sciences elected Vavilov a corresponding member, and in 1932 a full member. He converted the physics laboratory of the Academy of Sciences into the Institute of Physics, which was named after Lebedev. Since 1932 he has been the director of this Institute. From that time he has also been deputy director of the State Institute of Optics, in charge of research work.

Vavilov is recognized as one of the most prominent physicists in the Soviet Union. His work is mainly devoted to the problems of optics, more especially to luminescence and fluorescence. He has investigated the basic features of luminescence which, before his studies, were chiefly known empirically. He studied the phenomenon of elimination of the luminescence of solutions by different admixtures and has formulated a theory of this phenomenon based on the resonance interaction of molecules. These studies led him to the further development of the new sensitive method of analyzing substances, the so-called "luminescent analysis", which is now being applied on an ever wider scale in medicine, geology and industrial production.

Vavilov has developed a new source of cold light by converting ultra-violet radiation arising during gas discharge in mercury vapours into a visible light by means of covering lamp bulbs with luminophores. The technology of production of such gas-filled lamps covered with luminescent compounds was worked out under his guidance. Such lamps are three to four times more economical than incandescent lamps and give radiation similar to daylight.

Vavilov also founded a new branch of physical optics—the visual method of observing quantum fluctuations of light. He proposed and put into practice the daring idea of studying fluctuation of light energy by means of direct visual perception, making use of the exceptionally high sensitivity of the human eye. On the basis of immense experimental data, Vavilov has proved the quantum intermittent character of radiation and light absorption. He has also established new laws of physiological optics.

Vavilov is the author of many important studies in other branches of physical optics, among which especially noteworthy is his discovery and investigation (together with his disciple Cherenkov) of a new fundamental phenomenon—luminosity of a special type which arises in some media when electrons move within them at a speed surpassing that of light in the same media. Under his direction a number of special optical devices have been designed at the State Institute of Optics for military needs, as well as for industrial glass manufacture.

Vavilov has translated Newton's studies in optics from Latin into Russian; his historical commentary on Newton's work is widely known in scientific circles. In addition, he has published a number of papers devoted to the materialistic foundation of modern physics as well as several popular books on physics. For many years he has edited the physics section of the Great Soviet Encyclopaedia, directed the publishing of a series of popular scientific books of the Academy, and edited works on the history of the natural sciences. Much of his time is spent in helping to train young scientists at Soviet research institutes and at the Moscow University.

Besides his scientific work, Vavilov takes an active part in public life. For a number of years he was a member of the Leningrad Soviet and at present is a Deputy from Leningrad City to the Supreme Soviet of the Russian Federation. During the war Vavilov did most important work in solving important defence problems, especially in designing complex optical instruments for the Red Army, Air Force and Navy. He was awarded two Orders of Lenin and the Order of the Red Banner of Labour, and won a Stalin Prize for his studies in physical optics.

BIOLOGISTS AND REHABILITATION

A PLEA for an 'international co-operation in science', the re-establishment of international relations in science and humanities with the present enemy countries and the role of botanists and biologists in the post-war world was put forward in a paper entitled "The plant scientist in world's turmoil" communicated by Dr Frans Verdoorn (of Arnold Arboretum and Editor, *Chronica Botanica*) to the symposium on "Biologists and Rehabilitation" held under the joint auspices of the Botanical Society of America and the American Association for the Advancement of Science at Cleveland, Ohio on September 13, 1944.

The aim of such an international organization would be: First, the exchange of information (scientific, professional and practical) in such a way that it will be available to anyone who can profit by it. Secondly, the attainment of objectives which individuals or scientists of a single institution or nation cannot accomplish. These may be either in pure or applied scientific research or they may be co-operative scientific or practical publications. Thirdly, the forming of an "espirit de corps" which may counteract the evils of human international politics and contribute towards the establishment of a commonwealth of nations.

These aims and objects can be attained (1) by the oldest and most important form—the publication of original research, in which every scientist takes part, uninterrupted even by war, every time he has an article or a book published, (2) by abstracting journals, international as well as regional, (3) by international congresses and meetings, and (4) by international societies or commission, responsible for the organization of international co-operative research. In biology most research is individual or at most institutional; whereas in other fields of science, *e.g.*, astronomy and geodetics, research has developed markedly along lines of direct co-operation, national and international. Due to lack of interest of many foremost biologists in international relations work, research in biology will remain individual. But, there are many scientific and applied scientific problems which could be better and easily solved by some form of international co-operation. For example, in taxonomy, some kind of concentrated attack is required for the terrible status of exotic cryptogamic botany; in pathology, an international basis of the methods of disease control is greatly needed; in horticulture, the results of the use of the hormones in propagation should be made international as has been recommended by the International Horticultural Congress. Moreover, in botanical and zoological nomenclature, there is necessity for unification of terminology, colour codification, etc., and this can be attained by international societies. Such work as has been initiated by International Association of Wood Anatomists could be done in many other fields. The work of reconstruction of herbaria and botanic gardens destroyed by war is also of an international character. Unification of various kinds of information and intelligence (either in original form or in abstracts) is also highly stimulating and of direct use for the research worker. Such work includes address books containing a list of research workers with a census of current research, indexes of various kinds, *e.g.*, the *Index Herbariorum*, publications, which bring together various kinds of information and intelligence, discussions, notes, news, etc. *Chronica Botanica* should become the official professional organ of an international society and individuals who cannot give indefinitely the necessary time and money should not undertake such publication work. International co-operation would also be required for a new complete guide to the literature of the plant sciences; semi-scientific publications like the *Index Kewensis*, *Index Londinensis*, and the proposed *Index Botanicorum* should be an international effort.

None of these in itself is very important but, taken together, they are helpful and inspiring and well worth the effort.

Speaking of the re-establishment of relations with the newly crushed Fascist countries, especially with Germany, Dr Verdoorn said, "It is the scientists' duty to the world, to re-establish relations with enemy colleagues *both* individually and through meetings, congresses, and international commissions, *in all fields* to the fullest possible degree and as soon as circumstances permit. We must do this whatever practical commands for dealing with Germany, German split States, etc. may be, in order that the German scientist will not go "underground". The world of science needs him, but the world at large needs him still more. The mistakes made after the last war when most international co-operation in science was started in France, more by politicians

than by scientists, and restricted to Allied and neutral countries, must not be repeated, even though we know that some of our enemy colleagues will use purely scientific co-operation for other purposes."

Referring to agriculture in the post-war world a fresh outlook is emphasized by (1) improved nutrition for human beings, (2) methods of breeding and the use of substances that regulate growth, (3) world exploration to obtain and maintain material for breeding purposes, (4) the changed fertilizer situation, (5) utilization of waste and by-products and (6) problems of insect and disease control. To these it is proposed to add a closer relation between science and government and we might call this borderland 'biopolitics', which will recall a related field of research 'geopolitics', developed by and first used in the Axis countries. Biopolitics and Geopolitics may be the ways along which scientists will find it possible to reach those groups which they hitherto failed to influence.

Want of international co-operation, led to the extinction of the international association of botanists, so enthusiastically started before the war (1914-18), by Scott, Goebel, Von Wettstein, Trelease and many others. In the present war, the biologists, *e.g.*, botanists, agronomists, zoologists, entomologists, psychologists, and bacteriologists have contributed in larger numbers and in more intensive ways to the war effort, than in any previous war.

Men of science form the only group in society which knows that the concepts and ideas by which politicians and the accepted organizers of human relations are guided are mostly wrong, based on misconcepts, old superstitions and false intuitions, yet they have left not only the administration of but also most of the study of administration of human life and world affairs, in the hands of people who are not very appreciative of what a century of progress in the science of life has achieved. Therefore, we scientists are more truly responsible for the chaos of today than any other part of the society.

The resources, strength and endurance of the allied countries have brought the war to an end, and the men of science are once again in a very favourable position, as he will remain free in the post-war world, not in all but in much more than half of the Allied territory. How will he use this freedom of thought and action?

Better knowledge of and better training in biology might well revolutionize the citizen's attitude towards essential problems of life and human relationships. (*Nature*, *154*: 595-599, 1944).

IRRIGATION AND FOOD PRODUCTION IN INDIA

Sir William Stampe, Irrigation Adviser to the Government of India, addressing the East India Association in London, recently said that, scientifically viewed, India had little or no need to fear the vagaries of weather. He observed, "As one flies over these arid areas of India, one cannot but wonder why millions of tons of horse-power in the hills above should crash to waste yearly within sight of toiling peasants, beneath whose feet millions of tons of water sweep silently through sands to the seas". He believes that 'one-third of the additional quantities of food required for a yearly increase of 5,000,000 in the population and to raise the nutrition standard of 150,000,000 under-fed people could be procured by improved agricultural methods, leaving two-thirds to be obtained from expanded irrigation'.

To secure adequate food grains, an immediate increase of 12,000,000 acres in the cropped area is necessary, with the addition of 2,000,000 acres every year, to offset the rise in population. Sir William believes that the whole of alluvial India can be rendered fertile if exploitation of the hidden water resources of the Ganges plain (the 'lost river Saraswati of Hindu mythology), through the simultaneous expansion of widespread hydro-electric power and the development of irrigation by pumping such as has been recently shown in the United Provinces, is carried out.

It is estimated that at least one to two million acres could be added annually to the alluvial areas in Northern India, and there is room for 60 to 70 million additional acres of irrigable land in India during the next 10 to 15 years.

Attempts to investigate sub-soil reservoirs is now being carried on in conjunction with the Geological Survey of India. Appraisal of available water resources and their possible development will be one of the most important functions of the activities of the expanded Geological Survey of India.

EXPANSION IN THE GEOLOGICAL SURVEY OF INDIA

We have already reported on Government plans for extensive exploration of India's mineral and water resources, which is indispensable for the successful execution of the post-war plans for industrial and economic development. The scheme involves expansion of the scope of the Geological Survey of India and will cover (*a*) preparation of geological maps, (*b*) economic geology, (*c*) engineering geology and water supply, (*d*) geophysical work, and (*e*) dissemination of information.

To give effect to the scheme, the cadre of the geological officers, hardly exceeding 30 during pre-war days, will be raised to 125 as soon as possible. As an immediate step, additional staff of geologist has been sanctioned, bringing the cadre strength t 96. This will involve an increase in expenditur

on geological surveying to about Rs. 25 lakhs in five years. The present annual expenditure on geological survey is about Rs. 6 lakhs.

As a contrast to this, it is reported that Russia spent Rs. 50 crores on geological survey in 1936 and employed over 5,000 geologists for the purpose. Britain, a very small and a geologically well-explored area, spent Rs. 9 lakhs a year before the war, where the activities of State-employed geologists were supplemented by much valuable work carried out by the universities and mining companies.

Geologically, India is as yet little known ; about a tenth of its area of 1,547,679 sq. miles having been mapped. It is estimated that, on the basis of an average survey of 350 sq. miles by one geologist, about 200 geologists would be required to complete the geological mapping of India, on the standard scale, in 15 years.

Plans for the expansion of laboratories, library, museum, drawing office, chemical, mineralogical, petrological and palæontological work are being prepared, consistent with the increased field activities.

The universities in India, working under many handicaps, have carried out considerable geological field work in recent years, and we would like to point out that a closer co-operation of the Geological Survey with the universities and other non-official academic bodies will considerably help the progress of field work in Geology.

In its earlier days, the Geological Survey of India had on its staff eminent palæobotanists, and invertebrate and vertebrate palæontologists, who laid the foundation of Indian geology. Unfortunately, the study of fossils is now utterly neglected by the Survey. The universities are, however, best suited for palæontological investigations, and if the Survey is unable to undertake such investigations in future, adequate facilities should be created in universities for such studies.

BI-CENTENARY OF SIR WILLIAM JONES

THE bi-centenary of the birth of Sir William Jones, founder of the Royal Asiatic Society of Bengal, which falls in January, 1946, will be celebrated in Calcutta. The Bi-centenary Committee has decided to celebrate the occasion with a number of special publications, *viz.*, (1) a new series of monographs that would include 'Ashvaghosha' by Dr B. C. Law, 'Inscription of Camboja' by Dr R. C. Majumdar followed by 'Kols of Central India' by Dr Griffiths, 'Upper Atmosphere' by Prof. S. K. Mitra and others, (2) a commemoration volume containing articles on Indian history and culture (ancient and medieval periods), Islamic culture and literature, Indian vernaculars, Indian history (modern period) and progress of scientific studies in India, to be prepared in collaboration with eminent scholars and edited by Sir Jadunath Sarkar and Dr R. C. Majumdar, and (3) an annotated edition of Kalidas's Sakuntala, with the English translation of Sir William Jones, and a life sketch, cultural activities and full bibliography of the latter's writings, to be prepared by Dr Kalidas Nag.

NOBEL PRIZE FOR PENICILLIN

Reuter has just flashed the news of the award of this year's Nobel Prize in medicine to Sir Alexander Fleming of the London University, and to Dr Ernest Boris Chain and Sir Howard Walter Florey of Oxford University in recognition of their contributons to the discovery of penicillin and of its therapeutic applications. The expectation that a Nobel award will go to the discoverers of penicillin, the wonder drug, was largely held throughout the world ever since the announcement of the remarkable bactericidal action of the drug.

Sir Alexander Fleming, Professor of Bacteriology in the University of London and St. Mary's Hospital Medical School, discovered penicillin almost by accident in 1928 and used it for the isolation of microbes. Sir Howard Florey separated the therapeutic penicillin, now used on human beings. Dr Chain was one of his team-collaborators who worked on penicillin at the Oxford School of Pathology.

NOBEL PRIZE FOR URANIUM FISSION

THE Nobel Prize in Physics has been awarded to Dr Otto Hahn, the discoverer of Uranium Fission which is the cardinal principle of the atomic bomb. Born on March 8, 1879, Hahn started life as a young organic chemist in an industrial concern and later developed an interest in radio-activity. He worked with the British scientists Ramsay, Soddy and Rutherford. In 1912, he became director of the radio-active section of the Kaiser Wilhelm Institute at Berlin-Dahlem. His famous work which led to the discovery of the uranium fission is now known throughout the world over and has appeared in almost every scientific paper, technical or popular. He is also the discoverer of mesothorium and radiothorium. According to a recent newspaper report, Prof. Hahn is now in the U. S. A.

SCIENCE IN INDUSTRY

FOOD YEAST

THE serious shortage of animal protein in most of the countries of the world as a direct consequence of the war has stimulated widespread interest in the possibility of using yeast protein for human consumption. In an earlier issue of this journal, we reported the Government decision to construct a food yeast plant in India. Recently, in a paper read before the Royal Society of Arts, Dr A. C. Thaysen of the D.S.I.R. described the story of the development of food yeast in Germany, U. S. A., England and her colonies.

The nutritive value of certain micro-organisms is, however, no new knowledge. Long before the results of the present large-scale experiments on the nutritive value of yeast were available, people frequently used micro-organisms in the preparation of bread, beer, cheese, soya sauce and certain milk preparations. The beer used in the early middle ages contained an appreciable percentage of the yeast. In tropical and sub-tropical countries, the people consumed large quantities of yeast through the country made beverages. Modern refined methods of beer making, which have replaced the older crude practices, have deprived the consumer of a valuable source of protein and B vitamins.

The recrudescence of interest in the nutritive value of yeast towards the end of the 19th century followed the economic problem of disposal of the surplus brewers' yeast in Europe and America. Chemical analysis then undertaken revealed the high protein content, as much as 50 per cent, of dried yeast, and successful attempts were made to utilize it as cattle feed and as a source of protein in patients suffering from inflammatory conditions.

In the World War I, shortage of protein concentrates for stock-feeding led the German workers to further investigate the subject with a view to devising some method of large-scale utilization of the brewers' yeast. Following the work of Pasteur and Duclaux, they devised a method of producing a certain type of yeast from inorganic nitrogen, provided sugar was supplied either in the form of molasses or any other cheap form, but did not attempt large-scale production due probably to shortage of sugar.

The inter war period witnessed great interest in the dietetic value of micro-organisms with special reference to their protein and vitamin contents. Particular mention may be made of the work of Osborne and Mendel in 1919 and of Macrae and his collaborators in 1942 in the U. S. A. The nutritional level of a diet containing only maize protein of low dietetic value was found to rise to a much higher value, when yeast protein was added to it in small quantities. Some micro-organisms can very rapidly synthesize protein and water-soluble B vitamins from inorganic materials in the presence of adequate supply of energy in the form of sugar and starch and hence constitute the most potent source of these nutritional requirements. It is estimated that 245 tons of protein can be synthesized from half a ton of living yeast in 24 hours.

The supply of sugar in abundant quantities, Dr Thaysen pointed out, constituted the bottle-neck in the large-scale production of food yeast while the war was in progress. One ton of food yeast requires, for its production, 1·7 tons of sugar or its equivalent in starch. Normally sugar-producing countries should not have any difficulty regarding the needed supply of sugar in the form of molasses of waste sugar or starch in the form of rotten bananas and citrous fruit or apples, surplus maize or other grains, waste potatoes, etc. Some parts of the British Empire, such as the West Indies, the African colonies, the Middle East, India, Canada and Newfoundland, were more favourably placed with regard to the supply of cheap carbohydrates. A food yeast plant, with a daily output of 12 tons, is near completion in Jamaica, and the Governments of India, South Africa, Australia, and New Zealand are planning to erect similar plants in the near future.

Food yeast would be available at a price within the means of everybody. One pound of the product would not cost more than a shilling and would supply a person with 45 days requirement for additional high grade proteins and vitamin-B concentrates.

The extensive need for food yeast after the war when animal protein will be available in sufficient quantity has been questioned by some nutrition experts who have refused to give it any more importance than a temporary war-time measure. They advocate a complete return to animal protein and suggest an increase in the purchasing power of the poorer sections of the community, now prevented from consuming animal protein in their diet. Although a happier solution, it involves a bigger economic issue. There is little prospect of a very large percentage of the world population being able to afford costly animal protein in the immediate future, and it stands to reason that food yeast will

be welcomed as a potent source of protein and vitamin for many years to come.

ALCOHOL AND FUEL FROM SULPHITE LIQUOR

A NEW process of obtaining butyl alcohol and fuel from waste sulphite liquor (*The Chemical Age*, August 25, 1945), recently developed in the U. S. A., is stated to have greatly relieved the pulp industry of its vexed problem of disposal of the waste sulphite liquor. Waste sulphite liquor contains about 2 per cent of fermentable sugar from which to produce butyl alcohol, an essential ingredient of the plastics and other industries. The process will make available 22-23 lb. of butyl alcohol, 10-12 lb. of acetone and about 3 lb. of ethyl alcohol from 100 lb. of this sugar.

Production of butyl alcohol in quantity from sulphite liquor requires the presence of certain growth promoting factors, including biotin, another unidentified factor, and perhaps some vitamin. Older methods of producing alcohol from sulphite liquor all employed molasses as a supplier of this growth factor and were too expensive to lend themselves to large-scale production. The new method has dispensed with molasses, and yeast is produced without it ; this has reduced the cost to a level at which large-scale production of butyl alcohol from the waste liquor will be economic.

A new type of fuel appearing somewhat like coke and rated as having about 6,000 B.t.u. per lb. is another important by-product from the sulphite liquor. It is precipitated in the first stages of the process as a very heavily insoluble substance which forms crystals on drying. Its fuel efficiency compares very favourably with 5,000 to 8,000 B.t.u. in wood and about 12,000 in coal. The new fuel burns like coal, giving off undesirable sulphurous odour. Recovery of this fuel would make available about 75 per cent of the fuel requirement of the pulp mill digesters for the production of the pulp and the liquor.

The method further ensures large quantities of chemically pure yeast, high in nutritional value and vitamin content, which may be used in home, by commercial bakers, and as fodder for livestock.

POWDER METALLURGY

POWDER metallurgy as a distinct metallurgical process has been known and practised from very early times. But several technical difficulties and limitations long prevented it from attaining any practical importance, although its certain advantages in several directions over such time-honoured processes as forging, casting, machining, etc. were never overlooked. During recent years, however, the technology of powder metallurgy has made such rapid strides that it is fast developing into an important industry by itself, with widespread applicability and growing prominence. It is not undue optimism to expect powder metallurgy to become in future an important industry for making machine parts, of which forging, casting, or machine tool and such other established industries may well be apprehensive.

An article in a recent issue of *Scientific American* describes the special advantages of powder metallurgy as a method for manufacturing machine parts for specific uses. Its application still lies in the production of special machine parts which are either difficult in, or cannot be satisfactorily made by, other processes. Such 'speciality' applications include materials or parts of controlled porosity, as in the porous or self-lubricating bearing and filters or screens ; solid metals such as tungsten or tantalum products whose high melting points do not permit of the use of ordinary melting and casting practices ; mixtures like non-alloyable combinations like copper and lead for copper-lead bearings, or tungsten carbide and cobalt for carbide tools ; production of refractory metal parts for electronic tube service, magnetic cores for radio and telephone use, where absolute purity of the material is indispensable ; Alnico magnets, etc.

The process of powder metallurgy proceeds through simple stages. Metal powders of desired particle size are placed in a mould and compressed in a mechanical or hydraulic press. A previous treatment in a blending machine is necessary in the case of metal parts involving the use of more than one metal or particle size distribution. The selection of the powders of proper purity, size, size distribution, flow characteristics, etc. plays an important part in determining the quality and mechanical properties of the final product. Want of correct particle size distribution, for instance, leads to poor packing, undesirable density and porosity, and consequently poor mechanical properties of the finished part.

The solid parts from the press, commonly known as 'green' briquettes, are then subjected to a sintering operation consisting in heating the parts to a suitable temperature in vacuum or in an inert or reducing atmosphere. The sintering temperature is usually much less than two-thirds of the melting point of the metal, although in certain cases it may approach the very melting point itself. Through this operation, the parts are consolidated and strengthened. The process, however, brings about undesirable but unavoidable dimensional changes and, therefore, necessitates a final sizing operation.

The final strength and size of the finished parts depend on the strength of the press. Great improvement in the design and efficiency of modern mechanical and hydraulic press has now virtually

removed these two serious limitations of powder metallurgy.

Is powder metallurgy economic and can it stand competition with other methods now widely practised? The high cost of metal powders (20 cents or about As. -/10/- a pound for standard grade of copper; from 10 cents to one dollar a pound for various grades of iron powder) and dies, requirement for complicated machineries and relatively low mechanical strength of powder products may appear to militate against its widespread use. But its several advantages more than compensate for the relatively high cost of powder metallurgy products. We have already referred to its special applications in the making of quality parts. It is a much faster process than all others in vague; it can turn out parts at the rate of 1600 per hour or even 500 per minute. Unlike processes involving machining, casting sprues, forging flash, etc., powder metallurgy is particularly free from material waste. In large-scale production of parts, powder metallurgy has already proved economic. Despite its great progress and increasing application, it is still regarded as a special metallurgical method suited to certain specific purposes.

SOVIET EXPERIMENTS ON PLANT HYBRIDIZATION

A. Wechsler, Secretary, Soviet Committee on Plant Researches, gives a brief account of how the nature of certain familiar and cultivated plants is being radically changed by Soviet scientists who are crossing them with wild varieties. Professor N. Tsitsin, for example, has crossed cultivated wheat with couch grass. His experiments have given rise to entirely new varieties of winter and summer wheat. These new hybrids are impervious to fungus diseases. The grain has no tendency to fall from the ear; it mills well, and produces excellent bread. The plant does not droop, and the yield is two to two-and-a-half tons an acre. Some of Tsitsin's wheat/couch-grass hybrids withstand the severe Siberian winters. Others are perennial varieties that stand up well to drought, saline soil and fungus diseases; one type has produced two crops annually for several years running in the southern regions of Central Asia.

More recently, Tsitsin has developed a promising variety of perennial rye by crossing rye with couch grass.

The crossing of wheat with wild-growing varieties of elimus (*giganteus* and *arenarius*), which is impervious to heat, cold and drought, opens up entirely new prospects for the semi-desert regions of the Soviet Union.

A. Krasniuk has crossed cultivated rye with a wild-growing grain plant to produce a hybrid that is biologically adapted to conditions of drought and frosts, and yields a good harvest in poor soils and bad climates. Moreover, this hybrid serves as a perennial fodder crop.

A. E. Derzhavin has produced a perennial wheat, yielding both grain and hay, by crossing cultivated wheat with wild-growing perennial rye. The wheat-rye hybrids are impervious to fungus diseases. Derzhavin has provided Soviet farmers with another useful hybrid which grows profusely in semi-arid, sandy solid, producing fresh, succulent fodder when the pastures are dried up. This he did by crossing cultivated annual sorghum with wild perennial sorghum.

A. Yablokov, working in another field, has crossed the aspen and the Turkestan pyramidal poplar. The result is the pyramidal aspen, with all the advantages but without the drawbacks of the parent trees. The aspen provides good wood for building, and for making matches, plywood and cellulose; but it grows slowly, and suffers badly from heart rot. The poplar grows quickly and also produces good timber. Another of Yavlokov's successes was the crossing of the Turkestan poplar with the white or silver poplar. The Turkestan poplar is very common in Central Asia, but is rarely met with in the European part of the U. S. S. R., especially in the north. The white or silver poplar, on the other hand, stands up to heavy frosts and does well in the north. The hybrid grows very rapidly and is impervious to frost or drought. The same scientist has crossed the wild hazel, common in the U.S.S.R., with one of the better sorts of sub-tropical havel from Barcelona. The nuts of the Russian white hazel are very nutritious, while the bush itself serves to hold the soil and prevent erosion. The hybrid has the additional advantage of being impervious to frost; the nut has a high albumin and fat content.

By crossing the Jerusalem artichoke with the sunflower, B. Scnibrya has produced an entirely new plant. He has combined the perenniality and tubers of the artichoke with the high harvest yield and big oily seeds of the sunflower.

Many years of experimentation have now given Soviet farmers a tall, heavily foliaged hybrid which produces green silage at the rate of 28 tons per acre. The stalk has a high sugar content (17 per cent when green, and about 53 per cent when dried). A type of molasses similar to that obtained from sorghum can be obtained from this stalk, which when dried produces a fodder flour with a 50 per cent sugar content. The stalk of this plant contains a large quantity of saccharose, amounting to about 77 per cent of the total sugars. This promises to be a new raw product for the manufacture of crystal sugar. This remarkable plant has still other uses. Its leaves contain a certain amount of rubber which may profitably be used in industry after the molasses have been extracted.

CEMENTED CARBIDES AND IMPREGNATED DIAMOND TOOLS

DARA P. ANTIA

IT was in the year 1898 that Moissan[1] experimenting with the electric arc furnace produced what the chemists identified as tungsten carbide, a very hard material to which a scratch hardness of 9·8 was assigned on the Moh's scale of hardness. About 1912 this high hardness of tungsten carbide was first utilised in making jewel bearings for meters. In Holland compositions of tungsten and cabalt were employed as a substitute for diamond dies for drawing wires.

With this start the development of tool materials was fairly rapid. About 1919 tool and die materials of tungsten carbide were made by process of powder metallurgy. Crushing tungsten carbide to a fine powder, pressing it in iron dies to pieces of an accurate size and shape and heating them to a temperature below the melting point produced more durable tool material than could be obtained by melting. In America carburised and cemented compositions consisting of tungsten, carbon and titanium with about 6 to 10 per cent nickel or iron were employed for drawing dies and tool edges. German investigators cemented tungsten carbide particles with up to 10 per cent cobalt, producing tool and die compositions which are the basis for modern tools for machining cast iron, non-ferrous metals and such substances as bakelite, porcelain, glass and hard rubber. Much use is also made of them as dies for drawing wires and rods. These materials are known as cemented tungsten carbides or more commonly by their various trade names.

In general cemented carbide tools are made by crushing and powdering crystals of tungsten, tantalum, titanium and other hard carbides which are cemented together by a binder from 3 to 20 per cent cobalt or other material by sintering. They are manufactured in several different compositions which are adapted to cutting various materials under different conditions. The different grades are obtained by varying the percentages of the various carbides, the amount of binding material, the size of the carbide grain, the sintering temperature and other factors to produce the desired characteristics. The harder grades which in general contain smaller amounts of cobalt binder tend to excessive brittleness and can be used only for lighter cuts. In general increase in toughness is obtained at the expense of hardness.

The tungsten carbide compositions containing a certain percentage of tantalum or titanium carbide are much more satisfactory than the straight cemented carbides for cutting steel. Some tantalum carbide entirely free of tungsten carbides are among the most satisfactory materials for cutting steels.

The following table gives the range of compositions for the different cemented carbides.

Type of Material.	Constituents per cent					
	WC	TaC	TiC	Co	Ni	W
Tungsten carbide ..	85-97			3-15		
Tantalum (plus columbium) Carbide		72-85			6-13	12-20
Tungsten and tantalum carbides ..	30-77	17-57		6-13	Sometimes used	
W and Ti carbides ..	45-89		5-35	6-20		
W, Ti and Ta carbides	20-84	5-30	5-30	6-20		

The first step in the production of cemented tungsten carbide is the production of pure tungsten powder from the ores of tungsten. A method commonly used is described below.

Production of Tungsten Powder

The most common ores of tungsten are wolframite, $Fe(Mn)WO_4$ and scheelite, $CaWO_4$. Ferberite and Hubnerite are of minor importance. The tungsten content of the ore as mined is usually from 0·5 to 2%. The ores are concentrated by combined gravity and flotation methods. The concentrates contain from 60 to 75% WO_3, the chief impurities being Fe, Mn, Ca, Si, As, Sb, Bi, Cu, Sn, Ti and Mo.

The next step in the manufacture of tungsten powder is the separation of tungstic oxide from the other minerals in the ore. The method used depends on whether the ore is wolframite or scheelite. If wolframite is used the concentrates are fused with sodium carbonate and the sodium tungstate extracted from the melt with water. A mixture of 115 parts of sodium carbonate with 100 parts by weight of tungstic oxide in the ore is ball-milled to pass a 100 mesh sieve and is charged into a gas fired reverberatory furnace. The temperature is kept at about 800°C.

The mass after removal from the furnace is cooled and crushed and the sodium tungstate leached out with water. On evaporating this solution, crystals of sodium tungstate are obtained which are purified by agitation with an excess of calcium chloride solution. A white precipitate of calcium tungstate or artificial scheelite is obtained. This is

thoroughly washed by decantation and treated with hydrochloric acid giving WO_3 99·5% pure. The impurities are FeO, Al_2O_3, CaO and SiO_2.

If scheelite is the ore used, it is decomposed with HCl in a steam heated, rubber-lined vessel. The scheelite is ground to about 120 mesh and the temperature used is about 70°. After about five hours' treatment nitric acid is added to oxidise impurities. The tungstic acid obtained is allowed to settle and the liquid syphoned off. The sludge is washed four or five times. It contains about 98% WO_3, the impurities being iron, calcium and silica.

The tungstic oxide obtained by either of the above processes is further purified by treatment with ammonia, forming crystals of ammonium-para-tungstate which are then treated with hydrochloric acid.

It must be stated at this stage that the tungsten carbide for use in cemented carbides can either be obtained from the tungsten obtained from the reduction of tungstic oxide or straight from WO_3. In either case the fineness of the oxide has considerable influence on the properties and structure of the finished material and it is essential that the particle size of the oxide be closely controlled. In general in the decomposition of the tungstate solution the following effects are noted.[2]

(1) The colder the solution the finer the oxide.
(2) More concentrated solutions of either the acid or the tungstate give coarser oxides.
(3) The more slowly the ammonium tungstate solution is added to the acid the finer the oxide.

The particle size of the oxide can also be controlled by precipitation, by varying the temperature of drying and subsequent firing. Calcining the dried oxide at 650°C. causes a definite increase in the size of the particles. The increase in particle size also increases the density of the oxide. The conditions are so controlled that a particle size between one and three microns is obtained.

Reduction of WO_3

Tungsten is reduced from its oxide in a variety of methods, the purity of the powder obtained depending upon the method used. The most common method of reduction is by the use of hydrogen. Reduction is carried out in a continuous tube furnace in which are fed iron or nickel boats charged with the oxide. The furnaces are heated either by gas or electricity. The furnace is about 12 feet long through which a temperature gradient is maintained. Reduction is done in two stages. In the first stage the temperature is raised to 700°C and only a brown oxide is produced which is a mixture of WO_2 and W. In the second stage some yellow oxide is added to the brown oxide and the mixture is raised to a temperature of up to 800°C. Hydrogen is led through purifiers and introduced from one end of the furnace and the boats from the opposite end.

The product of reduction is a grey powder, slightly caked into lumps. These are broken up and passed through a fine silk seive, the coarse materials being rejected.

The particle size of the reduced powder depends upon the temperature of firing, the time of reduction, the state of the original oxide and the concentration of water vapour in the hydrogen. The conditions under which poweders of various particle sizes can be produced are given in the following table.[3]

Dia. of particles	Max. Temp.	Hydrogen	Wt. of WO_3 per c.c. in boat
0·5 microns	800°C.	dry	0·05 gms.
2 ,,	830°C.	,,	0·5 ,,
4 ,,	900°C.	,,	1·0 ,,
8 ,,	1130°C.	Saturated with water	1·5 ,,
10 ,,	1200°C.	,,	2·0 ,,

Manufacture of Tungsten Carbide

The tungsten powder of particle size between one and three microns obtained by the method described above is ball-milled with enough lamp black to form WC. By the smearing action of the balls every particle of tungsten is coated with carbon. This mixture is then heated in a carbon tube for about two hours at 1,500°C. The resulting carbide is crushed and seived.

If WC is to be produced direct from the oxide, the oxide is ball-milled with lamp black and the mixture fired at over 2,000°C. The heating is conducted in an iron tube from which the evolved gases can escape. The resulting product is tungsten carbide, WC.

The tungsten carbide so produced is very hard but at the same time very brittle. The property of toughness without a great sacrifice of hardness is imparted to this material by cementing fine particles of the carbide by means of cobalt.

Manufacture of Cemented Tungsten Carbides

There are two processes used for manufacturing cemented tungsten carbides.

(1) The Cold Press process.
(2) The Hot Press process.

(1) *The Cold Press process.*—The tungsten carbide prepared as described, is ball-milled with the necessary proportion of fine cobalt (from 3 to 13%, depending upon the properties required). Cobalt powder is made either by reducing its oxide with hydrogen or is made electrolytically. Purity and particle size are again of great importance and additional precautions are necessary since fine cobalt powder is highly pyrophoric.

Ball-milling is done in steel bottles with steel balls. The time required varies with the tungsten employed and the particle size. Wet or dry mixing can be done, an inert organic medium being employed when wet mixing. Stearic acid, carbon tetrachloride or lard is added to facilitate moulding and to reduce the coefficient of friction of the balled material. The tungsten carbide particles get thoroughly coated with the cobalt powder. The mixture is then pressed in steel dies, at a pressure of 30 to 35 tons per square inch, to a desired shape with sufficient allowance for shrinkage during subsequent firing and sintering.

The modelled particles are then subjected to a presintering treatment in hydrogen for about half an hour at a temperature of 700°C. A shrinkage of about 15 to 20 per cent takes place during this process, and the material is sufficiently strong to be handled and filed or worked on a lathe without danger of breaking. The desired final shape is thus imparted to the material with sufficient allowance for shrinkage during final sintering.

The shaped articles are then packed in alumina and heated in an atmosphere of hydrogen for 30 to 60 minutes at a temperature between 1,350°C and 1,450°C depending upon the amount of cobalt used. A further shrinkage of 15 to 20 per cent takes place and except for final grinding or lapping the material is ready for use.

(2) *The Hot Press process.*—In this process simultaneous pressing and sintering is employed. Tungsten carbide and cobalt, ball-milled as in the cold press process are introduced into a graphite mould which is constructed to permit electrical heating and also provided with top and bottom plungers for applying pressure. A high current, over 2,000 amps. at 220 volts, is either passed through the top and bottom plungers, or the current is passed through the graphite mould using side electrodes. The pressure used is about 1,500 lbs. per square inch at a temperature of about 1,400°C. At higher temperatures lower pressures are used.

It is not always necessary to make tungsten carbide prior to the pressing operation. If tungsten, cobalt and carbon in proper proportions having the correct particle size are mixed together and then subjected to the simultaneous pressing and heating operation as described above, a material is obtained which in all respects is similar to that made from tungsten carbide and cobalt.

Though the physical properties of the sintered carbides produced by simultaneous pressing and heating process are far superior to the carbides produced by the cold press process, it is not generally used since it is expensive, and the graphite mould can be used but once.

Preparation of Tantalum, Columbium and Vanadium Carbides

The oxides of these metals are reduced by mixing with calcium and calcium chloride heated to 900 to 1,000°C in a sealed bomb in the presence of small quantities of excess calcium which is employed to remove residual air or moisture. A small amount of alkali metal such as potassium or sodium is also added in the charge to remove hydrogen. The bomb is heated for a time long enough to bring about the reduction of the metals. The bomb and its contents are then cooled to room temperature and the charge disintegrated by washing with water and dilute acid in such a manner as to prevent undue absorption of hydrogen or nitrogen by the metal powder. After the powder has been allowed to settle, the supernatant liquid is decanted, the powder washed with alcohol and ether and dried in vacuum.

Titanum powder is similarly made. Titanium tetrachloride is reduced with sodium in a bomb at low red heat.

The element columbium is practically always present in tantalum ores in varying quantities and is very difficult to remove therefrom. Hence, it is that some columbium carbide is always present along with tantalum carbide in tool compositions where tantalum carbide is used.

The carbides of the elements may be prepared by adding the required amount of carbon or gas coke to the powders of the metals and milling them together for about five hours. The milling produces a very intimate mixture of the materials which may then be fired at a temperature varying from 1,500° to 1,600°C. for about eight hours in a closed graphite tube in an atmosphere of hydrogen.

F. C. Kelley[4] makes compositions of tungsten carbide and tantalum carbide using cobalt as binding material. Both the carbides are milled to break them up to a fine powder capable of passing through 325 mesh. The carbides in the desired ratio are mixed with suitable amounts of cobalt, from 3 to 20%, and pressed to the desired shape in a hydraulic press. The pressed material is then sintered in a close graphite tube in a hydrogen furnace at a tem-

perature of about 1,400°C. for about one and a half hours.

Kelley has obtained satisfactory results with the following compositions.

Tungsten carbide	Tantalum carbide	Cobalt
70%	21%	9%
60%	27%	13%
70%	24%	6%
54%	40%	6%
43·5%	43·5%	13%

Nickel is also used as a binding material for tantalum carbides. A composition containing 78% TaC, 10% Ni, and 12% W has been reported to be very satisfactory. This material is made by comminuting the amorphous tantalum carbide and metallic tungsten in a ball mill, using nickel balls, in a bath of naptha, until the mixture contains tantalum carbide, tungsten and nickel in the required degree of fineness and the required proportions given above. The naptha is then removed entirely by heating in an electric furnace, under a partial vacuum, at a red heat. A piece is then formed from the dried powder of the desired shape and the piece heated in an electric furnace in partial vacuum.

McKenna[5] claims that in the tantalum carbides as used above the carbon is not present in the exact monatomic ratio to the tantalum, and that the material is amorphous in character in that it does not present crystalline form to the unaided eye. He uses compositions of macro-crystalline carbides, as he calls them, or mixtures or carbides in the true monatomic ratio to produce his "novel hard compositions of matter". The compositions he recommends as useful contain 74·6% TaC, 18% W and 7·4% Ni: and 78% TaC, 11·2% W, and 10·8% Ni. He also uses various amounts of macro-crystalline multi-carbides including TaC, CbC, TiC and ZrC, with various binders chiefly nickel and tungsten.

A new technique of manufacturing tantalum carbide, columbium carbide and multi-carbide substances of these with titanium carbide has been developed in which the metals are dissolved in a molten menstrum of aluminium in contact with carbon, at temperatures about 2,100°C. The macro-crystalline carbides are separated from the aluminium and aluminium carbide by acid attack and solution, leaving metallic-lustered crystals having an exact monatomic ratio of metal atoms to carbon atoms.

McKenna[6] also uses a tungsten titanium carbide in the form of a compound $WTiC_2$. This he describes as distinct from a mixture of tungsten carbide and titanium carbide as referred to by Comstock[7] and also distinct from mixed crystals of the two carbides as referred to by Schwarzkopf.[8] He produces $WTiC_2$ in crystalline form by a synthesis in a molten menstrum of nickel at a temperature above 2,000°C: $WTiC_2$ is recovered by removing the nickel by dissolving in aqua regia. It is then purified by leaching in platinum dishes with boiling hydrofluoric acid. Tool compositions are made as follows:

Hard carbide particles are ground in a ball mill having a hardened steel surface with balls about five-eighth of an inch in diameter. The mill is filled with naptha which has been previously treated with sodium to remove the impurities. After milling for a long time the charge is removed, the surplus naptha is decanted and the residue dried by air blast until it contains one to two per cent naptha. Finely divided nickel or tungsten or cobalt or other binder metals such as carburised tungsten or a mixture of such binding materials in the form of finely divided particles and mixed if desired under naptha in a colloidal mill, are added to the ground, hydro-carbon saturated, carbide materials; or preferably the selected carbide materials and binder materials are initially ground together in a ball mill. In this condition the mass is easily moulded and can easily be formed to any desired shape. An allowance of about 15 to 20% is made for shrinkage. The piece is subjected to a compacting pressure in a hydraulic chamber of the order of about 3,200 psi. The piece so formed is placed in an electric induction vacuum furnace, together with metallic magnesium in the proportion of one part of magnesium to 200 to 300 parts of the pieces, and the furnace is heated slowly to reach, in about two hours, a temperature of 1,315°C to 1,445°C, and kept at this temperature for about an hour. During the heating the furnace chamber is evacuated to obtain a pressure of from 7 to 40 microns of mercury by means of a mercury diffusion pump[9] connected to the furnace chamber. After the furnace has cooled the pieces are removed and are ready for use.

The following compositions are stated as giving good results:

45% $WTiC_2$, 17% TaC, 15%CO, and 23% carburised tungsten.

45% $WTiC_2$, 17% (TaCb)C, 15% CO, and 23% carburised tungsten.

75% $WTiC_2$, 25% CO.

50% $WTiC_2$, 17% TiC, 8% Ni, 25% carburised tungsten.

The author carried out some work at the Massachusetts Institute of Technology, Cambridge, Mass, U. S. A. using from 5 to 15 per cent of stainless steel powder as cementing material. Several compositions of tungsten, tantalum and titanium carbides

were tried. The results however were inferior to standard carbide compositions.

Action of the Cementing Material in the Cemented Carbides

Many investigations have been made in regard to the action of the cementing material in the cemented carbides. Wymann and Kelley[10] and S. Takeda[11] have investigated the equilibrium diagrams of the Co-W, W-C, Co-C and Co-W-C systems and have thrown much light on what happens when final sintering takes place.

It is understood that when the sintering temperature is raised above 1,400°C, there forms a liquid eutectic alloy of cobalt, tungsten and carbon. This alloy penetrates between the carbide particles by capillary action and in part diffuses into the carbide crystallites. As the duration of sintering is increased, a slight grain growth of the carbide crystallites takes place absorbing the small particles. Also upon cooling the smallest carbide particles are absorbed in favour of the larger ones and the tungsten carbide crystals dissolved by the liquid phase again separate out in extremely fine distribution.

Physical Properties of Cemented Carbides

The physical properties of the cemented carbides vary with different combination of constituents. In the case of cemented tungsten carbide alloys the density decreases with increasing amounts of cobalt; the hardness also decreases slightly but there is an increase in strength.[12] The hardness also depends on the particle size of the carbides and by decreasing the particle size an appreciable increase in hardness is noted. The finer grained carbide also resists abrasion to a greater extent. Porosity plays an important part in the ultimate values of strength, density and hardness. If there are many voids these values are lower. Porosity of course depends upon the final sintering temperature and as stated previously the temperature, pressure, etc., are closely controlled in the manufacture of these carbides.

Transverse Strength

Since the cemented carbides have very little ductility, they are tested by breaking a transverse test bar and calculating the modulus of rupture or maximum strength in the outermost fibre.[13] The figure so obtained for a 6·1 cobalt composition is 205,000 psi, about half that for high-speed steel, but have been exceeded in certain instances. The values mainly depend upon the amount of binding material.

The effect of moderately high temperature on the strength of cemented carbide containing 13% cobalt is shown in the following table.[13] They show a very good retention of strength at red heat and above.

Temperature °C.	Modulus of rupture, psi
Room temperature	225,000
800	183,000
850	170,000
900	141,000

The modulus of elasticity of cemented tungsten carbide with 13% cobalt has been determined by A. L. Kimball[14] as 79,000,000 psi. On compositions of high tantalum carbide with a bond of different nature the modulus of elasticity has been found to be 56,000,000 psi.

A test measuring the modulus of elasticity consists in utilising the Rockwell machine for applying a load and measuring the distance of flexure of beam of the carbide alloy, 0·125 in. thick and 0·150 in. wide, supported between one inch centres and pressed in the middle with a hardened steel ram of ⅛th inch radius. Each mark on the Rockwell C scale represents a movement of 2 microns or 0·002 mm. The idle load is 6·6 kg. and the flexure caused by the addition of 100 kg. is the measurement ovserved. Some observations of flexure as given by McKenna[15] are shown in the following table:

Binder %	Break Kg.	Rockwell A Hardness	Flexure with 100 Kg. load		Remarks
			Marks on C scale	Microns	
4	1530	91·8	22·5	45	Co + C + W bond
5	1540	91·8	22·5	45	Co + C + W bond
5	1740	90·0	23	46	Ni + W + C bond
8	2160	89·0	31	62	Ni + W bond
23	1600	91·6	37	74	alloy Co + W + C
27	1800	91·0	38	76	Ni + W alloy bond
27	2410	88·0	34	68	Ni + W bond
	4100	85·0	67	134	hardened 18-4-1HSS

The tortional modulus of elasticity has been determined by J. V. Emmons[14] for a sample containing 13% Co and was found to be 17,250,000 psi.

The compression strength of cemented tungsten carbide is the highest for any known material and is around 540,000 psi.

The coefficient of thermal expansion of cemented tungsten carbide with 13% cobalt as reported by P.

Hjndnert[14] is $6{\cdot}0 \times 10^{-6}$ per °C over a range from 20°C to 400°C.

Hardness

Hardness is the property of great practical importance in tool materials. The hardness of straight tungsten carbide is estimated as 9·8 on the Moh's scale of hardness. The addition of cobalt lowers the hardness in proportion to the amount of cobalt added.

Physical properties have been explained[15] as a consequence of chemical bond and distance between atoms in a chemical compound. This is based upon the idea that the atoms in a lattice are held together as the square of the valance and inversely as the distance between the atoms. The compounds compared must be of the same crystalline arrangement.

Some values of the figure $\frac{100}{V_a^{2/3}} e^{W}$ = atomic volume, are given in the following table. It is interesting to note that the rank of figures obtained by Moh's hardness test are consistent with the rank of figures obtained by calculation.

	NaCl	AgCl	Pb	TiN	VN	TiC	V	TaC
$100W^2$ V_a 2/3	18	19	63	268	280	435	491	452

The commonly used laboratory test for the hardness of cemented carbides is the Rockwell test. The Standard test with diamond cone and 150 kg. load is not used since the diamond breaks off too easily. The usual way is to use the 60 kg. load and take the reading on the Rockwell C scale calling it the Rockwell A number.

Thermal Conductivity

This is the most important property in cutting tools. H. A. Robinson[14] found the thermal conductivity of tungsten carbide with 13% Co to be 0·652 watts per cm. per sec. per °C with a deviation of ±0·025. This is about 50% greater than that of tool steel. The thermal conductivity of a tantalum carbide tool composition (78% TaC) as determined by W. Newcomer[13] is about 0·224 watts per cm. per sec. per °C.

McKenna[15] gives the following figures for thermal conductivity for hard tool materials.

Thermal conductivity Cal. per cm. per°C per sec.	Applications and Remarks.
0·199	WC :Co composition. Very good on light cuts on cast iron.
0·185	WC :Co composition. Cast iron cutting at high speeds.
0·141	WC :TaC+3%Co. Cast iron cutting below 300 ft. per minute.
0·108	WC :W-Ni bond. For malleable iron and steel castings.
0·084	Steel cutting grade of TiC :WC :Co.
0·043	Steel cutting tool of Ta, Cb and Ti. Carbides used at speeds up to 800 ft. per min.
0·068	Quenched and drawn H :S.S.

Coefficient of friction is important in materials to be used for cutting purposes. Seizing is a function of adhesion or coefficient of friction between the built up edge and the tool. Carbon tetrachloride is sometimes used as a coolent when using cemented tungsten carbide tools. The coolent forms a film on the surface of the material and lowers the coefficient of friction.

Cemented tungsten carbide tools are not found suitable for cutting steels. Tantalum carbide compositions with cobalt bond are generally used. More recently a composition of 77% TiC, 13% MoC and 10% Ni has been successfully used in Germany for drilling rods.

The physical properties of cemented carbides are summarised in the following tables.

Properties of Cemented Tungsten Carbides[14]

Cobalt per cent	3	6	9	13	20
Density gm. per c.c. at 21°C	15·04	14·82	14·56	14·10	12·54
Modulus of rupture as determined by transverse strength in psi	125,000	205,000	250,000	300,000	
Rockwell A hardness on C scale with 60Kg load	91·0-93·0	90-92	88-91	87-89	
Vickers Brinell Number	1380[1]	1450[1]	1365[2]	1255[2]	755[2]
Shore Monotron Number[3]	190	145		130	
Electrical resistance, micro-ohms per c. cube at 20°C	21·3	21·1	22·3	19·6	29·2
Temperature coeff. of resistance for interval 20-30°C	0·0047	0·0045	0·0043	0·0044	0·0038
Co-efficient of thermal expansion per°C over 20-400°C				$6{\cdot}0 \times 10^{-6}$	
Compressive strength in psi	(4½%Co) 890,000	680,000 730,000		540,000	

[1] 10 kg. load.
[2] 30 kg. load.
[3] Figures are the load to produce a penetration of 9/5000 in. The 190 readings were for 6% Co pressed ho while the 145 and 130 readings were for 6% and 13% Co.

PROPERTIES OF TANTALUM AND TITANIUM CARBIDES[14]

Combinations.	Rockwell A hardness	Density g./cc.	Modulus of rupture, psi
Predominantly tantalum carbide plus 13% binder ...	87·0	13·55	175,000
Equal amount of tungsten carbide and tantalum carbide +13% binder	87·2	13·65	250,000
Predominantly tungsten carbide plus tantalum carbide +13% binder	87·5	13·91	275,000
80% tantalum carbide, 12% tungsten metal and 8% nickel ...	88·4		250,000
75% tantalum (columbium) carbide, 13% tungsten metal, 12% nickel	88·3		275,000
72% tantalum (columbium titanium) Carbide 20%W, 8% Ni	91·0		185,000
Predominantly tungsten carbide plus titanium carbide and 13% binder	89·8	12·80	250,000
Predominantly tungsten carbide with increased amounts of TiC and 13% binder	90 0	11·95	240,000
Predominantly tungsten carbide with increased amount of titanium carbide and 13% binder	90·0	10·10	180,000

APPLICATIONS OF CEMENTED CARBIDES

The most important application of cemented carbides is in the form of tips for cutting metallic and non-metallic materials. As stated before tungsten carbide cemented with cobalt is used for machining cast iron, brass and other metals having tensile strength below 40,000 psi. The cutting speed is from two to ten times faster than with high speed steels.[16, 17] Compositions containing the intermetallic compound $WTiC_2$ are mostly used for machining of steels of tensile strength from 80,000 to 270,000 psi or from 167 to 552 Brinell hardness. Here again the tools can be used at cutting speeds much faster than with high speed steels or cast cobalt-chromium alloys. Carbides also find important applications in wire drawing dies, dies for extruding, sizing, drawing and otherwise forming rods, tubes, sheets and fabricated shapes of most metals. Being wear resistant cemented carbides find use in gauges, thread guides, pump valves for abrasive materials and for numerous other applications where a combination of high abrasive resistance and good strength is essential.

For most applications like tools, dies, etc. containing cemented carbides, the structural assembly is such that the weight and volume of the carbide portion is small compared with the supporting part which is generally brazed on to the steel shank or holder by copper, or silver solder. Direct welding is difficult due to large difference in the thermal expansion between cemented carbide and steel. A muffle type electric or gas fired furnace is used for brazing.

IMPREGNATED DIAMOND TOOLS

About 50% of all the diamonds mined are used in industry for the various purposes outlined in the following table and in about the proportion indicated.

Grinding wheel dressers	40%
Earth drills	25%
Wire drawing dies ...	15%
Stone saws	10%
Abrasive powder	5%
Lathe and boring tools ...	2%
Glass cutters	0·5%
All else	2·5%

Industrial diamonds are of two types. The black diamond (carbonado) and bort. The black diamond is the hardest known substance, being harder than gem diamond. The chief use of the black diamond is in the manufacture of drill bits for rock drilling and boring, while that of bort is in the manufacture of cutting tools which are used for turning hard rubber, ebonite, vulcanite fibre, metals and alloys, mica and other materials that dull other cutting tools quickly.

The difficulty of securing a small object like a diamond in a holder was very early realized and some very crude methods were used for mounting diamonds. For example in making diamond drills, holes were bored in soft steel and the diamond surrounded by a strip of copper was placed in the hole. The metal was then pinned round the hole by a punch. This method had several shortcomings. First, contact between the metal and the diamond was obtained over only a small part of the surface of the diamond. Second, the diamond was subjected to strain from unequal pressure which made it likely to crack. Finally the diamond was held in a metal which had a greatly different coefficient of expansion from that of the diamond, a factor which usually resulted in looseness, in vibration and in possible loss.

Edward Van der Pyl[18] has taken out a patent in which he makes grinding wheels using diamond grit embedded with a powdered bond. The bond is

either an alloy of 68% Cu and 32% Sn or 35-50% Cu and 65-50% Ni or 85% Cu and 15% Al or 65% Cu and 35% Mn or copper with 1-2% Be.

The diamond grit between 80 and 500 mesh is mixed with the bond powdered to 200 mesh. After mixing, it is cold pressed and then sintered at a temperature between 750 and 1,200°C depending upon the type of bond used.

Another method of making grinding wheels or wire drawing dies is to embed the diamonds in a casting of suitable alloys or metals. This method does not seem to be very satisfactory as intimate contact is not obtained between the metal used and the diamond. In addition there is no adhesion bond between the cast metal and the diamond and the low melting point metals generally used have a co-efficient of expansion greatly different from that of the diamond.

For several years the General Electric Company[19] carried out research for the purpose of obtaining maximum efficiency from diamonds by eliminating breakage and loss from the holders. Since diamond has an extremely high melting point it cannot be fusion-welded to any other body but if a satisfactory mechanical bond between the diamond and some other suitable substance were obtained the effective life of the diamond would be considerably increased. The G. E. C. found just the suitable material in cemented tungsten carbide which under suitable conditions has a peculiar adhesion for diamonds. The advantage in impregnating diamonds in cemented tungsten carbide are (1) the coefficient of expansion of diamond and the carbide are very close together, also the carbide does not undergo plastic deformation when cold, (2) because of the good thermal contact between the carbide and the diamond, the heat generated is dissipated much faster than it is in the case of other alloys or metals which do not make good thermal contact with the diamond. Evidently much care in sintering must be employed in regard to temperature control lest the diamonds be graphitised.

At present diamond impregnated carbides are principally used for wheel dressers but its use for grinding wheels, drills, core bits, etc. is increasing.

In the manufacture of wheel dressers[19] crushed diamond are mixed with tungsten carbide and cobalt and all the operations are carried out in the same way as when making cemented tungsten carbides. The method of manufacturing drills is practically the same except that a single surface layer of large diamonds is used. In core drills the diamonds are set individually in a tungsten carbide ring so as to perform most efficiently as cutting teeth. The ring is brazed to the tubular steel shank of the drill shaft. These tools are known as diamond impregnated carboloy.

There are some British patents for mechanically held diamond tools.[20] The diamond is clamped in suitably cut recesses and the life of the diamond is said to have increased a good deal.

References

[1] H. Moissan "The Electric Furnace" Easton, Pa., 1904.
[2] C. J. Smithells "Tungsten" 2nd Ed. Van. Nostrand, 1936 p. 23.
[3] C. J. Smithells "Tungsten" 2nd Ed. Van. Nostrand, 1936, p. 31.
[4] U. S. Patent No. 2,167,516 to F. C. Kelley.
[5] U. S. Patent No. 2,124,509 to P. M. McKenna.
[6] U. S. Patent No. 2,113,355 to P. M. McKenna.
[7] U. S. Patent No. 1,973,428 to G. J. Comstock.
[8] U. S. Patent No. 1,959,879 to Schwarzkopt.
[9] U. S. Patent No. 2,093,844 to P. M. McKenna.
[10] Wyman and Kelley, "Cemented Tungsten Carbide; A study of the Actions of Cementing Materials" *Trans. A. I. M. E.* (1931) Inst. of Metals Division p. 208.
[11] S. Takeda, "Action of Cementing Materials in Cemented Tungsten Carbide" *Science Report, Tohoku Imperial University* (Anniversary Volume) Oct. 1936, p. 864.
[12] W. P. Sykes "Cemented Tungsten Carbide Alloys" *Trans. A. I. M. E. 128*, 76, 1938.
[13] S. L. Hoyt "Hard Metal Carbides and Cemented Tungsten Carbide", *Trans. A. I. M. E., 89*, 9, 1930.
[14] A. Mackenzie "Cemented or Sintered Carbides" A. S. M. Handbook 1939, p. 909.
[15] P. M. McKenna "Tantalum Carbide Toll Compositions" *Trans. A. I. M. E., 128*, 90, 1938.
[16] E. W. Engle "Cemented Carbides" Powder Metallurgy, Published by A. S. M. 1942 p. 436.
[17] P. M. McKenna "Tool Materials (Cemented Carbides)" Powder Metallurgy, Published by A. S. M. 1942, p. 454.
[18] U. S. Patent No. 2,072,051 to Edward Vander Pyl.
[19] G. E. Taylor "Diamond Impregnated Carboloy" *General Electric Review, 37*, 97-99, 1934.
[20] "British Precision Diamond Tools". *Automobile Engineering, 26*, 353, 1936.

MEDICINE AND PUBLIC HEALTH

TRANSFUSION DANGER IN GIRLS

Dr Philip Levine, of the Ortho Research Foundation, reports in the *Journal of the American Medical Association* the dangers associated with the transfusion of blood to young women, girls or newborn girl babies without previous tests of their Rh blood group. Transfusion of incompatible blood to women has frequently resulted in severe illness or even death of their first-born babies years later.

Transfusion of Rh positive blood into Rh negative blood stream leads to a reaction resembling immunization against disease. Rh positive blood is destroyed in contact with blood in which such immunization has taken place. Immunization can be set up by very small amounts of blood and, once set up, will continue throughout the rest of the person's life. The Rh positive-killing anti-bodies in the blood may disappear in a relatively short time, but the tissues responsible for the production of these anti-bodies remain capable of responding far more rapidly to any invasion of Rh positive blood. Thus immunization becomes permanent although the presence of immune anti-bodies in the blood may not be revealed by blood tests.

In women who have suffered such immunization, an Rh positive baby would be killed or made very ill by its own mother's blood. Dr Levine reported the case of a young woman who had received seven transfusions of her father's blood when she was only six years old. Her first baby was born with the most severe form of erythoblastosis, originating from Rh incompatibility. In another young woman whose second baby was born dead, Dr Levine found that the mother's blood would not mix with that of the father although both had group O blood. This offered the first clue to the puzzling question of why many families would repeatedly have still births or their babies would not live for more than the first few days.

In the light of these experiences, Dr Levine advocates that no girl should be given blood without Rh test. He also strongly discouraged the common practice of giving new born babies an injection of blood in their muscles, as it may also lead to immunization. In such cases, the newly discovered vitamin K should be used as an anti-bleeding agent.

PENICILLIN IN SEVERE INFECTION OF ARMS AND LEGS

Successful results of penicillin injections into an artery in severe infections of hands, feet, arms or legs have been reported in an issue of the *Science News Letter*. Infection complicating diabetes and arteriosclerosis, which often results in gangrene requiring extensive amputation, is a condition which particularly responds to the artery injections of penicillin. Cases of infection and inflammation without pus formation and discharge and without death of tissues may be cured by one injection. Pain is often greatly relieved and even amputations may be rendered unnecessary. Where, however, amputation is unavoidable, penicillin injection may frequently succeed in saving more of the leg or arm, hand or foot than would otherwise be made possible. Artery has been recommended as the route for injection, since it is a most efficient way of concentrating the drug in the part of the body where infection is located. This also involves the use of much less penicillin than is required in oral administration or in injection into a vein.

BLOOD PROTEINS IN PHYSIOLOGY AND THERAPY*

B. MUKERJI and N. K. IYENGAR

BIOCHEMICAL STANDARDISATION LABORATORY, GOVERNMENT OF INDIA, CALCUTTA.

INTRODUCTION

THE knowledge of blood proteins and their therapeutic value that has been gained during the World War II enables us to approach the future with a very different view than was possible a decade ago to even the most far-sighted physiologists, biochemists or the physicians. The concept of blood as a therapeutic agent has been in vogue from times immemorial but physiological knowledge about blood and its functions began to crystallize only from 1616 when Harvey propounded his 'theory of circulation'. More than 300 years have elapsed since and physiologists have made many significant contributions to our present-day knowledge of blood. It is now textbook knowledge that blood is a fluid tissue with many different functions, chief amongst which are (1) maintenance of the functional inter-relationship of widely separated body cells by preserving the acid-base equilibrium and supplying them with fuel (food and oxygen) for their combustion ; (2) supplying the elements for their growth and reconstruction ; (3) relieving the tissues of their waste products of metabolism ; (4) equalisation of body temperature by distributing the heat generated by cell activity ; (5) carrying of chemical hormones to stimulate and co-ordinate cell activity.

That blood is composed of two distinct parts—a liquid part (the plasma/serum) and a solid part (the corpuscular or 'formed' elements) is recognised from the very beginning of knowledge about the phenomenon of blood coagulation. With the evolution and increased use of the microscope in biological studies and the development of 'vital staining' techniques with organic dyes during the last 100 years, phenomenal progress has been made in the study of the corpuscular elements in blood. The present position not only permits us to define and identify the various elements—the red corpuscles or *erythrocytes*, the white corpuscles, or the *leucocytes*, and the platelets or *thrombocytes*—by their structural and staining characteristics, but we are in a position to ascribe specific physiological functions to each of these constituents. Thus, the red corpuscles are known to be responsible for the respiratory functions of the blood, the leucocytes (which have again been sub-divided into several types) primarily for defence against infections and for ingestion of dead materials and foreign objects circulating in the blood stream, the platelets for blood clotting processes, etc.

Though the liquid portion of the blood constitutes nearly 60 per cent of the total blood volume, surprisingly little advance was made in our knowledge of plasma/serum even up to the first quarter of the 20th Century. Beyond the fact that the plasma is an optimum fluid medium for the preservation and suspension of the red cells in circulation, the importance of plasma or its component proteins *per se* was not clearly understood. Pickering[15] appears to be one of the first few physiologists to clearly enunciate that the plasma proteins must be looked upon as a closely-knit complex of inter-related substances of a protein nature and that it can function as a physico-chemical unit in maintaining the viscosity and colloidal osmotic balance of the blood. This hypothesis became the starting point of newer researches on the plasma proteins through the application of physico-chemical methods of electro-dialysis, differential salting with serial concentration of neutral salts, fractional heat coagulation and electrophoretic methods, etc. The difficulty of fractionating the different plasma proteins without 'denaturing' them was so great that significant progress could not be recorded until recently. Through the brilliant work of Dr Edwin J. Cohn[7] and his collaborators of the Harvard Medical School, carried out under the auspices of the American National Research Council, successful fractionation of the plasma proteins have now been effected, and furthermore, the part played by each of these fractions has been clearly indicated. Based on this new knowledge, an array of new therapeutic agents from blood proteins are being gradually elaborated which promise to unfold a new chapter in transfusion procedures, immunological practices, blood-grouping work, and neurosurgery. In this review article, an attempt will be made to present the modern status of knowledge in this field of plasma proteins with particular emphasis on their physiological and therapeutic aspects.

THE PLASMA PROTEINS

The plasma proteins can be broadly divided into 3 groups (1) Fibrinogen, (2) Globulins and (3) Albumins. Recent work has shown that each of these groups of proteins can be sub-divided into (1) Fibrinogen A and Fibrinogen B, (2) Alpha, Beta and Gamma Globulins, (3) Albumins. The classification of these proteins is based on their solubility behaviours, and their chemical and physiological properties.

* Re-written from a Lecture delivered by the senior author before the Annual Meeting (1945) of the Society of Biochemistry and Experimental Medicine in August, 1945.

Origin of Plasma Proteins.—Whipple and his co-workers[19] have ascribed the origin of 'fibrinogen' to liver. Working with completely hepatectomised rabbits, McMaster and Drury[16] have confirmed this. Without the liver, there appeared to be no power to regenerate fibrinogen. Kerr, Hurwitz and Whipple[17], Smith, Belt and Whipple[18] found that after the plasma proteins had been reduced by 'Plasmapharesis', regeneration of globulin occurred more rapidly than that of albumin. After haemorrhage, globulin appears to be more rapidly restored than albumin. In diseased conditions associated with reduction of plasma protein, albumin is usually lost first. The albumin is therefore the protein deputed to duty first and regenerated last. There is no evidence concerning the origin of these proteins, but the above facts suggest that the production of albumin and globulin are independent processes controlled by different influences.

Physiology of the Plasma Proteins.—Whipple, Smith and Belt[19] have demonstrated that the maintenance of a minimal plasma protein concentration is essential to life. The symptoms of extreme depletion of the plasma proteins resembled those of surgical shock *e.g.*, collapse, fall in body temperature, and increase in the rate of breakdown of body proteins. The plasma proteins do not appear to serve as sources of nutrition to the tissues.

The principal function of the plasma proteins, apart from the clotting property of fibrinogen, appears to be the maintenance of the physical and physico-chemical state of the blood. The proteins promote the mobility of the corpuscles, presumably lubricating the passage of the corpuscles through the capillaries. The paramount role of plasma proteins, albumin in particular, is to maintain the fluid-balance between the blood and the intercellular spaces and serous cavities. This is due to their osmotic attraction for water. The osmotic pressure of the plasma crystalloids, although relatively large (5,000 mm. of Hg., as against 30 mm. of Hg. for proteins), is of little influence on the fluid distribution, because the crystalloids can pass through the vessel walls with the water. The edematous leg of a dog perfused with Ringer's solution remains edematous but when perfused with serum, the edema is re-absorbed. Other factors, besides a deficiency of the plasma proteins, can cause edema. Increase of vascular permeability permitting proteins to diffuse into the extravascular fluids would also be expected to cause it.

The other function of the plasma protein is to act as buffers, as shown by Van Slyke, Wu and McLean.[13] They accordingly assist in the CO_2-carrying function of the blood and in neutralising acids which invade it. This property of the proteins appears to be of minor physiological importance, since more efficient buffers are present in blood.

The normal concentration of plasma proteins in human beings is about 6·5-8·5 grammes per 100 c.c. Three proteins, which are comparatively easily separated, are distributed as follows: fibrinogen (0·25 g.), serum globulin, (2·7 g.) and serum albumin (4·5 g.). The plasma proteins differ in molecular weight—that of fibrinogen is over 100,000, globulin about 100,000, albumin less than 60,000. Albumin, which has by far the smallest molecule, naturally possesses the greatest diffusibility. There are various physiological factors which affect the concentration of proteins in plasma. Age, sex, pregnancy, diet, cold, heat, muscular work, water drinking, hyperventilation, etc., have all some effect on the content of plasma-proteins. Decrease in total plasma protein concentration may be caused by loss through the kidneys, in proteinurea or by malnutrition, either from deficient diet, from a lowered assimilation ability on the part of the body, as in diabetes, or from protein wastage caused by infections and in nephritis. A marked increase of plasma protein content occurs in conditions of great dehydration.

Fractionation of Plasma Proteins

Fibrinogen.—It has the solubility of a globulin, but on account of its role in blood coagulation, has a unique significance. It spontaneously coagulates when ionised calcium salts are present or by heating to 55°C in a neutral solution. It can also be precipitated most easily by the addition of salts. The role of this protein in blood clotting is too well-known to require any enumeration. Very recently, it has been shown, that this is made up of two components, A & B, the latter an intermediate product obtained in the process of coagulation of fibrinogen by thrombin. Fibrinogen B is formed from fibrinogen A by the action of thrombin component A, with the liberation of thiol groups in the fibrinogen molecule. This intermediate, fibrinogen B, can be clotted by thrombin component B or by minute amounts of 2-methyl 1:4-napthoquinone (vitamin K) in 50% alcoholic solution. The mechanism of action of vitamin K is not known definitely but can be explained on the basis of the above finding. This suggests that vitamin K is either a prosthetic part of thrombin component B or that it converts a protein fraction into an oxidation—reduction system with a potential in the vicinity of that of vitamin K. The *in vitro* action of vitamin K in the coagulation of fibrinogen has been demonstrated by this work for the first time.

Plasma proteins can also be precipitated by such organic solvents as acetone or the alcohols. When this precipitation is carried out at ordinary temperatures, the protein is denatured and the solu-

bility in water of these precipitated proteins practically disappears, a phenomenon similar to that seen in case of denaturation of proteins by high temperatures. Mellanby[2], Hardy and Gardiner[3] and many other investigators[13, 18] have suggested precipitation at low temperature (5°C) to prevent denaturation. If denaturation can be prevented in this manner, alcohol precipitation has a decided advantage over salt precipitation since the protein obtained by the former process can be dried under a vacuum and the resulting product will be salt-free and water-soluble.

Globulins.—The globulins are readily removed by changing the *p*H of plasma or the salt concentration of plasma. They are completely precipitated by the addition of adequate quantities of anhydrous Na_2SO_4 or by saturation with NaCl or $MgSO_4$ or half-saturation with Am-sulphate.

As stated previously, three kinds of globulins, Alpha (α), Beta (β) and Gamma (γ) have been differentiated by their electrophoretic mobility. Alpha- and Beta-globulins have greater electrophoretic mobility than Gamma globulins (Tiselius[4, 5, 6]). In plasma or serum, Beta-glubulins reveal a double peak whereas alpha globulin is represented by a single peak.

Alpha globulin consists mainly of water-soluble pseudo-globulins with an iso-electric point of *p*H 5 and is precipitable by higher concentrations of ammonium sulphate than are required for the precipitation of beta- and gamma-globulins. The so-called mucoglobulin[8] as well as certain carbohydrate-rich globulins[9, 10], probably belong to the alpha-globulin group. The alpha- and beta-globulins are different immunologically from gamma-globulins and most anti-bodies have been associated with the gamma fraction, which increases in amount with immunity. In febrile conditions, alpha-globulins largely increases[11, 12, 13]. In lipoid nephrosis, in which fibrinogen increases in the plasma, the alpha- and beta-globulins also increases whereas the gamma-globulins and the albumins are greatly diminished. Conversely, albumins and to some extent, gamma-globulins are found in lymph and perhaps in other body fluids[14] in larger amounts than alpha and beta globulins.

Beta globulin fractions are often highly coloured ; some blue, some deep yellow, some rich in lipoids, and some rich in other organic molecules associated with this group of proteins. These are precipitable by neutral salts or by alcohols[15] at concentrations greater than those necessary for the precipitation of gamma globulins. It is possible to characterise the proteins as beta or gamma globulins by electrophoretic analysis of whole serum or plasma. These appear to consist of various euglobulins and pseudo-globulins. The concentration of beta globulins in sera increases in lipoid nephrosis, cirrhosis of the liver and other pathological conditions.

Gamma globulin is the fraction that separates by incresaing the concentration of salt or ethanol added to plasma after the removal of precipitated fibrinogen. Tiselius (*loc. cit.*) has characterised this fraction by electrophoresis. The analysis of proteins into electrophoretically different fractions has been most valuable in the characterisation and identification of the various globulins. At neutral reactions, the fastest moving component of either plasma or serum is the albumin. The gamma globulins move more slowly in the electric field. Certain anti-bodies have been located in the gamma globulin fraction. Prothrombin is generally precipitated from plasma with the gamma globulins and its iso-electric point is also near *p*H 5. The gamma globulin fraction contains molecules which have not been identified with euglobulins and which may therefore be called pseudoglobulins.

Albumins.—Albumins are precipitated by complete saturation with Am-sulphate. Albumins are soluble in water and are precipitated by neutral salts or by organic solvents at higher concentrations than are most globulins. They are prepared by half saturation of plasma with Am-sulphate and the albumin in the filtrate is later purified. The iso-electric point of serum albumins is *p*H 4·8 and they have far greater electrophoretic mobility than the globulins. Immunologically they can be sharply differentiated from the gamma globulins. There are different kinds of albumins in the serum, *e.g.*, carbohydrate-containing albumin, carbohydrate-free albumin, etc. Enzyme-proteins like choline-esterase, phosphatase, lipase, iodine-containing proteins, H-hemocuprein, etc., all come with the albumin fraction. Many of these remain to be crystallised. Their smaller size, larger net charge, lower viscosity, more symmetrical shape, associated with their far greater solubility and stability in solution separate them in property and function from the more labile assymetric and viscous globulins.

The albumins are the most stable of the plasma proteins, far less readily denatured than others. Though the albumins reperesent less than 60% of the plasma proteins, they are responsible for nearly 80% of the osmotic efficiency of the plasma. Its stability in solution permits albumins to be easily dispensed for transfusion purposes in 25 per cent solution which is isoviscous with the whole blood. The isoelectric, salt-free albumin can be prepared as a dry white powder which can be redissolved at any concentration and with any diluent.

Cohn's Fractions

The fractionation process that has been developed by Cohn (*loc. cit.*) yields all of the components of

human plasma in five major fractions. The number of fractions has purposely been kept as small as possible to facilitate and render large-scale processing of plasma economical. The following diagram from Cohn (1945) will help in explaining the position.

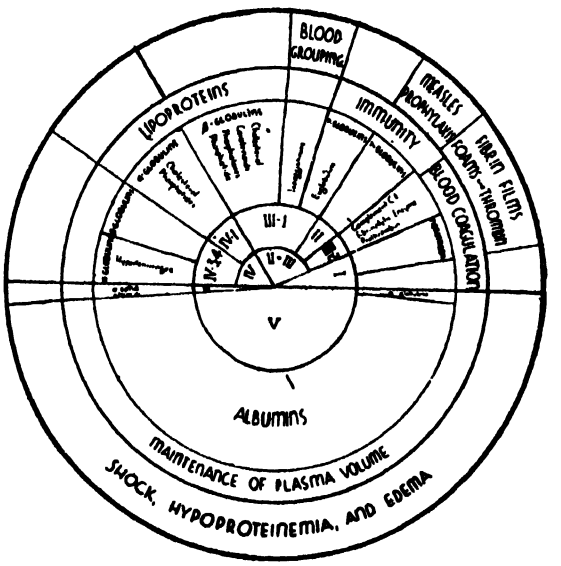
Fraction I—Fibrinogen (the structural element of the blood clot).

Fractions II and III—(*a*) all of the prothrombin, (*b*) all of the immune globulin (for which tests have been carried out), (*c*) isohemagglutinins and Rh anti-bodies (of value in blood grouping), (*d*) all of the carotenoids and such part of the cholesterol and phosphatids of plasma as appear to be associated with beta rather than alpha globulins, (*e*) midpiece of the complement, (*f*) probably innumerable other components of plasma which are not yet recognised by their chemical and biological properties.

Fraction IV—Remaining globulins.

Fraction V—Albumins.

PLASMA PROTEINS
Their Natural Functions and Clinical Uses and Separation into Fractions.



(From Cohn- *'Science'*, *101*, 51, 1945).

THERAPEUTIC USES OF PLASMA PROTEINS

Whole plasma or *whole serum*, though occasionally used before this war, is now a regular and popular therapeutic agent in the armamentarium of the modern field and casualty surgeon. It is being increasingly used in practically all cases of shock due to penetrating bullet wounds, crushing injuries, acute and subacute hemorrhages where whole blood transfusion is not possible, and in severe cases of burns. Modern technique has made it possible to store plasma or serum in the 'liquid state' ready for immediate transfusion. In the liquid state, however, there is the possibility that the more labile components, *e.g.*, the prothrombin and fibrinogen, complement and the anti-bodies, would deteriorate with time. This difficulty however can be overcome by freezing and drying under high vacuum the plasma or serum by a process which has been described as 'lyophilization'. Dried serum has been successfully produced in Calcutta itself at the 'Blood Bank' located at the All India Institute of Hygiene and Public Health, and has saved many lives at the casualty clearing stations in battle fronts.

Albumin.—By virtue of their osmotic property, the equilibrium between the water and the electrolytes in the blood and in the tissues is largely (80%) performed by this protein. The albumin fraction can therefore be easily used as a volume-restoring fluid for the treatment of shock, hypoproteinemia, œdema, etc., and can easily replace whole plasma or serum for such conditions. Human serum albumin has also been recommended by the Blood Substitutes Sub-committee of the American National Research Council to the armed forces and like plasma, it has been processed in large amounts from the blood collected by the American Red Cross. Though this is not yet available in India, there is every possibility that in the near future, this fraction would also be produced at the Calcutta Blood Bank. It has one great advantage of 'stability' (can withstand heating to 50°C for 100 days) and as such, should be of particular value in tropical climates, where preservation of plasma or serum and its transportation under refrigerated conditions is not readily possible.

As a salt-poor concentrate, albumin offers scope for use as a diuretic agent and has already proved its value in certain types of œdema.

Gamma globulins.—The control of certain infectious diseases with plasma proteins has attracted attention in recent years. Pooled normal or convalescent plasma has long been used in the control of measles or similar infectious diseases. As many of the anti-bodies are present in the gamma globulin fraction of the plasma, it is to be expected that the use of concentrated gamma globulins should serve the same therapeutic end as the administration of convalescent serum. This has actually proved true in the prevention of measles and several other virus diseases, *e.g.*, infective hepatitis. Of the plasma proteins, about 11% is gamma globulin. Two fractions of gamma globulin has been separated, one richer in euglobulin and the other (Fraction II) in the more soluble pseudoglobulin. The latter fraction represents approximately 5% of the plasma proteins and from the point of view of public health administration, appears to be the most important

fraction, which will justify in a large measure the continuance of the war-time 'Blood Banks' as important peace-time organisations also.

Fibrinogen, Thrombin and Fibrin Films.—For stopping the flow of blood, thrombin is the only component of the clotting mechanism which must be supplied. In the subfractionation of Fractions II and III to yield the gamma globulin anti-bodies in Fraction II, prothrombin is automatically first separated. This prothrombin may be converted to thrombin with human thromboplastin and may be kept ready for reconstitution and immediate emergency use in blood clotting when necessary.

For the most effective use of thrombin in hemostasis, however, it is necessary to apply it with a matrix which can hold the thrombin in the bleeding area until clotting is completed. Such a matrix can be prepared from human fibrinogen and thrombin.

Various forms of fibrin foam can be prepared suitable for haemostasis in small areas as well as for packing large cavities such as tumour beds. Fibrin foam has proved very effective in neurosurgery in controlling bleeding from the *dura mater,* tumour beds, dural sinuses and large cerebral veins. In general surgery, it has been used successfully in the cut surface of liver and kidney in jaundiced patients, in thoracic operations and in stopping bleeding in hemophilia. The porosity of the material allows it to absorb water, saline, or thrombin solution and it can be used in conjunction with sulphonamides or penicillin. For these purposes, three bottles are supplied in practice (1) Thrombin, (2) Sterile isotonic saline and (3) Fibrin foam. The foam is cut into pieces of appropriate size in the dry state and then soaked in a solution of thrombin before application.

Alpha and Beta globulins and Isohemagglutinins.—The alpha and beta globulins concentrated in Fraction IV have recently been subdivided into fractions which are stable and can be dried from the frozen state. The exact functions of these globulins have not yet been discovered but they can be easily used as pure and innocuous therapeutic agents once their use is found.

Isohemagglutinins have been prepared from Fraction II which are being increasingly used in the typing of blood groups.

Conclusions

By the employment of newer physico-chemical methods to the fractionation of plasma proteins and their separation in the form of dry stable powders, which can be made to retain all the original biological properties as present in the whole plasma and which can be reconstituted at any time, a new horizon is getting unfolded before Physiology and Therapeutics. Modern physiologists must reorientate their earlier views and begin to look upon blood, not just as *one* of many other tissues (*e.g.*, skeletal tissues, muscular tissue, etc.) of the body with *one* or possibly a group of similar functions, but as a very *complex* tissue with multiple component factors, every part of which is destined to perform an important natural function. Clearly, therefore, it would be an advantage to make available as many as possible of its diverse cellular, protein and lipid components, in separated and concentrated forms, as specific therapeutic agents of value in different conditions in the interests of the most effective and economical use of human blood. The Hospital Casualty Departments of the future, for example, need do no more than keep a few bottles of dry human albumin, instead of liquid whole plasma or processed dried plasma. Now that the pseudo-globulin fractions responsible for immunity in measles are available in pure form for direct passive immunization, there will no longer be need for immunization with convalescent measles serum with its concomitant risk of 'serum jaundice'. As research progresses in these newer fields, it is expected that more epoch-making discoveries would be made, which would enable us to utilise blood and all its elements and derivatives in the most economical way possible. Blood has always been considered by the primitive mind as the 'most valuable' fluid, and verily, recent researches seem to indicate that each of its myriad components is of supreme importance to the body.

Bibliography

[1] P. Lyons, *Nature, 155,* 633, 1945.
[2] Mellanby, J., *Proc. Roy. Soc.* (B), *80,* 399, 1908.
[3] Hardy and Gardiner, *J. Physiol., 68,* 40, 1910.
[4] Tiselius, *Nova Acta Soc. Sci. Upsala, 4,* 7, 1930.
[5] ——— *Biochem. J., 31,* 313, 1464, 1937.
[6] ——— *Trans of Faraday Soc., 33,* 524, 1937.
[7] Cohn, E. J. *et al, J. Am. Chem. Soc., 62,* 3386, 1940; *Science, 101,* 51, 1945.
[8] Hewitt, *Biochem. J., 32,* 26, 1540, 1938.
[9] Sorensen, *Compt. Rend. Trans. Lab. Carlsberg, 12,* 213, 1915-17.
[10] Kekwick, *Biochem. J., 32,* 252, 1938; *33,* 1122, 1939; *34,* 1248, 1940.
[11] Longsworth *et al, Chem. Revs., 24,* 211, 1939; *J. Expl., 71,* 77, 1940.
[12] Van Slyke, Wu & McLean, Quoted in 'Quantitative Clinical Chemistry, Methods' by Peters & Van Slyke, 1932.
[13] McInes and Longsworth, *Science, 89,* 438, 1939.
[14] Lentscher, *J. Am. Chem. Soc., 61,* 2188, 1939.
——— *J. Clin. Invest., 19,* 313, 1940
——— *J. Clin. Invest., 20,* 99, 1941.
[15] Pickering, The blood plasma in health and disease, 1928.
[16] McMaster and Drury, *Proc. Soc. Biol. Rev. 26,* 490, 1929.
[17] Kerr, Hurwitz and Whipple, *Am. J. Physiol., 47,* 370, 379, 356, 1918.
[18] Smith, Belt and Whipple, *Am. J. Physiol., 52,* 54, 1920.
[19] Whipple, Smith and Belt, *Am. J. Physiol., 52,* 72, 1920.

Only a few selected references are given here. Interested readers are referred to the following references where a detailed account will be found.

Chem. Rev., 28, 395, 1941; *Proc. Amer. Phil. Soc., 88,* 159, 1944; *J. Clin. Invest., 23,* 1944; *J. Am. Med. Assoc., 126,* 469, 674, 680 & 944, 1944.

BOOK REVIEWS

Plants and Plant Science in Latin America—Edited by Frans Verdoorn, Ph.D., Pp. XI + 384 (with 83 plates and text illustrations). Waltham, Mass, The Chronica Botanica Co.; Calcutta, Macmillan & Co. Ltd., 1945. Price—$6·00.

The house of Chronica Botanica inaugurated at Leiden (Holland) in 1935, transferred its activities to U. S. A. in 1940 amidst the turmoil of war and since then has been publishing "A new series of plant science books" under the editorship of Dr Frans Verdoorn. The book under review is the Volume 16 of this series - part 2 of which consists mostly of articles (revised) already published in *Chronica Botanica, Vols. 6 and 7* (1941-42)—and deals with the vegetation and natural resources, as well as the present status and future of various branches of plant sciences in Latin America, with the aid of about one hundred authorities in the U. S. A., Latin America and other countries. The aim of these articles have been to give the agronomist, botanist, forester, phytopathologist, etc. (in all parts of the world) the information which he may need when starting work on the wild or cultivated plants of Latin America.

That this subject would be the most appropriate contribution that could be made at present to the improvement of international relations and co-operation in the plant sciences– a field which presents in Latin America many problems of a great, often truly international importance—is elaborated in the introductory essay entitled, "The Plant Scientist in the World's Turmoil" by the editor himself and is briefly summarized elsewhere (see SCIENCE AND CULTURE, *11*, 247, 1945).

Special features are the plates often reproduced from classical publications and part I of the book. The latter provides extensive introductory chapters on "Some Problems of Tropical American Agriculture" by Popenve; "A phytogeographic sketch of Latin America" (with several maps) by Johnston and Smith; "Principal Economic Plants of Tropical America" by Fosberg (dealing with food plants —native and introduced); Spices and flavor; perfumes; beverages, stimulants and narcotics; pharmaceutical plants; insecticides; oil plants, vegetable dyestuffs; fibre plants; timbers; fuels, latex-yielding plants, etc.); "Historical Sketch" of botanical progress by Pennel; and also regional descriptions of almost all the Latin American provinces, *e.g.*, one by Goodspeed (who organized numerous expedition to Andes) "on the vegetation and plant resources of Chile".

Chapters of a general (non-regional) interest of Latin American countries deal with geological and paleobotanical facts by Darrah; Ethnobotany (a new subject and throwing much light on the interrelations of primitive man and plants); climatology and meteorology by Stone; soils and soil conservation by Pendleton and Bennett; Forestry by Beven; problems and procedure of Hevea rubber culture by Rands; Plant pathology and medical mycology by Muller and Emveous, etc. "Notes on Cinchona Culture" by Pennock dealing with its nomenclature, cultural operations, control of diseases, grafting, as also experiments to acclimatize the plant in new area, to hybridize, and to see the effect on the alkaloid content of the bark by colchicine treatment, may be read with profit by quinologists in India and elsewhere.

There are special supplements—one by Krug who reports in detail on plant breeding, genetics and cytology in Central and South America and the other by Verdoorn containing addresses of plant science institutions, stations, museums, gardens, societies and commissions classified on a regional basis, so that any one interested may profitably contact.

In addition to data in his own field, the specialist will find much useful and stimulating information on vegetational and agronomic problems in general, on the organization of research, principal Latin American plant science periodicals and address list of research workers.

A list of travel books of botanical interest and of plant collectors and location of botanical collections of Latin American plants by Dr Lanjouw (prepared under difficult circumstances) shows the usefulness of such as "Index Herbariorum", as an invaluable guide to all engaged in taxonomic research.

A note on the conservation of Nature in the Americas by the Chairman of the Pan-American Committee for wild life protection with detailed information of Pan-American "National Parks", "National Reserves", "Nature Monuments" and "Strict Wilderness Reserves" is a subject of international importance.

We have nothing but admiration for the case with which weighty matter is handled throughout and we wish that similar books be written dealing with other countries and if such books were to

approach the readability of Verdoorn's, we will not complain.

The publishers should be congratulated on the general excellence of the get-up.

A. K. G.

A Class-Book of Botany –(for intermediate and medical students) by A. C. Dutta, Sixth Edition (Revised and Enlarged). Pp. XIV + 464 with 575 text figures. Oxford University Press, Calcutta, 1945. Price—Rs. 7/8/-.

This text book of Botany has stood the test of time. Teachers and students will welcome this sixth edition of an already widely-used text books, exactly suited to the requirements of the intermediate and medical examinations of the Indian universities and those familiar with the previous editions will readily recognize the improvements brought about by a complete revision of the subject-matter.

The text for the phanerogams has been profusely illustrated with many new, neat and accurate diagrams and sketches from Indian examples in an attractive manner but those on the cryptogams are not similarly illustrated. It is high time that text books on Indian botany should be written, based on the life-history of types indigenous to India.

The names of common Indian plants in different provincial dialects have been cited and this is one of the chief features that further distinguishes this book from the rest of its kind in India.

Prof. Dutta with his long experience as head of the departments of Botany and Biology at the Cotton College, Gauhati (Assam), responsible for the teaching of Botany and Biology and as an examiner of the Calcutta University, has spared no pains to incorporate the results of recent research and to render the subject up to date lucid and methodical, thus providing a well-laid foundation for the appreciation of higher botany.

The publishers deserve to be congratulated for the get-up of the book, specially the print and neat diagrams, in spite of war-time restrictions.

A. K. G.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

VARIATION IN THE EMBRYONIC MOVEMENTS DURING THE PROCESS OF HATCHING IN *LABEO ROHITA* AND *CIRRHINA MRIGALA*

The study of the development of the carps has been made to certain extent by the researches of Khan,[1] Ahmed[2] and Mookerjee,[3] but up till now none of them has recorded the exact movement of the embryos. The present note is to give the details of the embryonic movements in both *Labeo rohita* and *Cirrhina mrigala* commencing from the starting point onwards upto the time of hatching.

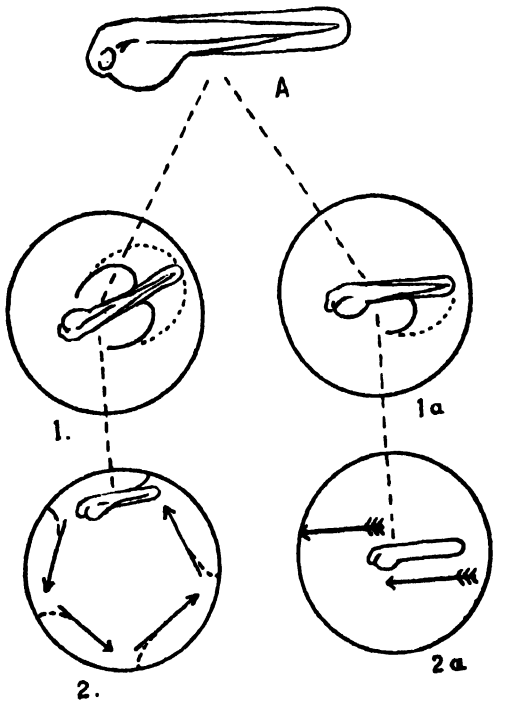
During our stay at Chandrakona Road Station in the district of Midnapore in the month of June, 1945 we have had the opportunity to observe the spawning of carps in the neighbouring confined breeding grounds or *bundhs* (Mookerjee).[4] We have collected the eggs of *Labeo rohita* and *Cirrhina mrigala* for the sake of studying their life histories and after sorting them carefully, following the measures adapted by Khan[5] and Mookerjee[6] observed them at intervals under the binocular dissecting microscope.

We have observed about 200 eggs of both the species at different stages and the first sign of movement has been marked in both at near about 12 hours since fertilisation. The nature of movement at this stage is very feeble and is restricted to mere throbbing only. The movement becomes more vivid as the embryos grow old. The observations regarding the specific variation in the movement of the embryos before and at the time of hatching have been recorded below.

At about the 14th hour since fertilisation the embryo of *Labeo rohita* starts swimming in the perivittelline fluid within the egg case. During this process it keeps its ventral surface upwards and remains obliquely with head downwards (Fig. 1).

The swimming stroke starts from the caudal end and the tail after beating against the yolk sac deflects upwards with a considerable velocity until it reaches the cephalic end. The movement is continuous and becomes more vigorous as it approaches

When the embryo reaches the stage just before the hatching a marked change takes place in connection with its movement and the position within the egg case. Instead of keeping the ventral surface upwards and the body placed obliquely with head downwards it becomes almost horizontal with ventral surface downwards and moves topsy turvily knocking at every point within the egg case with the virulent strokes of the tail (Fig. 2).



Diagrammatic representation of the hatching movements in *Labeo rohita* and *Cirrhina mrigala*. 1. 1st stage of movement in *L. rohita;* 1a. Corresponding stage in *C. mrigala;* 2. Final stage of movement of the embryo at the time of hatching in *L. rohita;* 2a. Corresponding stage in *C. mrigala*.

At about the 17th hour the embryo comes out and at the time of hatching it always tries to break the egg case by striking it with the splashing of the tail. When a slit is thus formed to the egg case the embryo comes out through it by its head end.

The embryo of *Cirrhina mrigala* starts swimming in the perivitelline fluid in the period between 13th to 14th hours since fertilisation. Within the egg case it usually remains horizontal and continues swimming either on its side or keeping the ventral surface downwards. The swimming strokes are not so vigorous as that of *Labeo rohita*. The stroke of the tail starts from the posterior end of the yolk sac and ends when it reaches upto the long axis of the body. The tail seldom reaches the cephalic portion and the embryo shows to and fro movement which begins at regular intervals (Fig. 1a).

The embryo hatches out between 16 to 18 hours since fertilisation. At the time of hatching the to and fro movement becomes more rapid and the embryo pokes the egg case successively at a few points only with the head till a slit appears. After the appearance of the slit it escapes through that by the head like *Labeo rohita* (Fig. 2a).

H. K. Mookerjee
D. N. Ganguli.
M. Islam.

Dept. of Zoology,
Calcutta University,
Calcutta, 3-9-1945.

[1] Khan, H., *Proc. Ind. Acad. Sci., 18,* 1B, 1-13, 1943.
[2] Ahmed, N., *Proc. Nat. Ins. Sci. Ind., 10,* 343, 354, 1944.
[3] Mookerjee, H. K., Science and Culture, *10,* 400-402, 1945.
[4] Mookerjee, H. K., Science and Culture, *11,* 48, 1945.
[5] Khan, H., *Bomb. Nat. Hist. Soc., 29,* 958-962, 1924.
[6] Mookerjee, H. K., *Modern Review,* 87-91, 1945.

SOME N¹- AND N¹-ALKYLENE-BIS-SULPHANILAMIDES

Crossley, Northey and Hultquist,[1] and Northey and Hultquist[2] prepared 1 : 2-bis-sulphanilamidoethane by reacting *p*-acetaminobenzene-sulphochloride with ethylenediamine and reported it to be of somewhat limited pharmacological activity. The promising pharmacological action of N¹-dodecyanoyl sulphanilamide[3] indicated that it would be worthwhile to make a systematic study of bis-sulphanila-

Name of the Compound	M. P. of N¹-substituted compounds $NH_2\text{-}C_6H_4\text{-}SO_2\text{-}NH\text{-}(CH_2)_n\text{-}NH\text{-}SO_2\text{-}C_6H_4\text{-}NH_2$	M. P. of N⁴-substituted compounds $NH_2\text{-}C_6H_4\text{-}SO_2\text{-}NH\text{-}(CH_2)_n\text{-}NH\text{-}SO_2\text{-}C_6H_4\text{-}NH_2$
	°C	°C
Methylene-bis-sulphanilamide	296° (decomp.)	196°
Ethylene-bis-sulphanilamide	228-229°	204°
Trimethylene-bis-sulphanilamide	170°	180°
Tetramethylene-bis-sulphanilamide	150°	138°
Pentamethylene-bis-sulphanilamide	142°	155°

mides linked at N^1- and N^4-positions through an alkylene chain.

By refluxing the potassium salt of *p*-acetaminobenzenesulphanilamide with excess of different alkylene dibromides, and subsequently removing the excess of the dibromide by steaming, the acetyl compounds were obtained which were hydrolysed to the corresponding N^1-substituted alkylene bis-sulphanilamides given in the table.

The N^4-substituted alkylene bis-sulphanilamides (also listed in the table) were prepared by heating sulphanilamide with excess of respective alkylene dibromides under reflux, and neutralising the liberated hydrobromic acid from time to time with anhydrous sodium carbonate.

For the preparation of both N^1- and N^4-methylene bis-sulphanilamides the reaction with methylene dibromide was conducted in a closed vessel under pressure owing to its volatility.

H. L. Bami
B. H. Iyer
P. C. Guha

Organic Chemistry Laboratories,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 4-9-1945.

[1] Crossley, Northey and Hultquist, *J. Amer. Chem. Soc.*, *62*, 532, 1939.
[2] Northey and Hultquist, *Amer. Chem. Abst.*, U. S. Patent No. 2258162, 1942.
[3] Crossley, Northey and Hultquist, *J. Amer. Chem. Soc.*, *61*, 2950, 1939.

SOME N^1—AND N^4—HETEROCYCLIC-ACYL SULPHANILAMIDES

Sulphanilamide derivatives like sulphapyridine, sulphathiazole and sulphadiazine having heterocyclic substituent at N^1-position have found wide application in chemotherapy. With a view to making a systematic study of the effect of 'heterocyclic-acyl' substituents at N^1- and N^4-positions, sulphanilamide (SA) or *p*-acetaminobenzene-sulphochloride (ASCl) or the potassium salt of *p*-acetaminobenzene-sulphonamide has been made to react with (*a*) quinolinic acid, (*b*) diethyldihydrocollidine dicarboxylate, (*c*) collidine dicarboxylic acid, (*d*) chelidonic acid, (*e*) chelidamic acid, (*f*) furan-dicarboxylic acid, (*g*) oxalodiglycollic ester, (*h*) diethyl-furo-3 : 4-*p*-dioxane-2 : 5-dicarboxylate, (*i*) cantharidin, (*j*) thiodiglycollic ester, and (*k*) diethyl-thiene-3 : 4-*p*-dioxane-2 : 5-dicarboxylate, either in the form of acids or esters or acid chlorides, as the case may be. N^4-Furoylsulphapyridine,[1] N^4- and N^1-nicotinylsulphanilamide,[1, 2] N^4-quinolinylsulphanilamide[3] and N^4-2′-pyrrolidone-5′-carboxy-4-aminobenzene-sulphonamide,[4] are reported to be chemotherapeutically active.

When (SA) reacts with the anhydride of quinolinic acid, compound (I) is formed, which on treatment with thionyl chloride yields (II) apparently through the formation of the acid chloride of (I) and subsequent elimination of hydrochloric acid. When (SA) reacts with quinolinyl dichloride in the absence of any solvent, compound (III) is formed. When heated under vacuum (*b*) condenses with two molecules of (SA) yielding compound (IV), whereas fusion of (SA) with collidine dicarboxylic acid and not its ester, yields (V). Fusion of (SA) with (*e*), (*f*) and (*i*) yields the products (VI), (VII) and (X), respectively. Fusion of (SA) with the diesters (*g*), (*h*), (*j*) and (*k*) under vacuum gives the products

No.	Name of the Compounds Formed	M.P. °C.
I	Pyridine-2-carboxy-3-carbo-N^4-sulphanilamide	Melts at 210°, solidifies & remelts at 260°
II	Pyridine-2 :3-dicarbo-N^4-monosulphanilamide	310-311° (decomp.)
III	Pyridine-2 :3-dicarbo-N^4-disulphanilamide	293° (decomp.)
IV	Dihydrocollidine-3 :5-dicarbo-N^4-disulphanilamide	285° (decomp.)
V	Collidine3 :5-dicarbo-N^4-disulphanilamide	260° (decomp.)
VI	Pyridon-2 :6-dicarbo-N^4-disulphanilamide	322° (decomp.)
VII	Furan-2 :5-dicarbo-N^1-disulphanilamide	255° (decomp.)
VIII	3 :4-Dihydroxyfuran-2 :5-dicarbo-N^4-disulphanilamide	Shrinks at 250° and decomp.
IX	3 :4-Ethylenedioxyfurane-2 :5-dicarbo-N^4-disulphanilamide	Decomposes above 275°
X	1 :4-Endoxycyglohexane-2 :3-dimethyl-2 :3-dicarbo-N^4-sulphanilamide	234°
XI	3 :4-Dihydroxythieno-2 :5-dicarbo-N^4-disulphanilamide	Decomposes
XII	3 :4-Ethylenedioxythieno-2 :5-dicarbo-N^4-disulphanilamide	do.
XIII	2-Carboxy-furan-5-carbo-N^1-acetylsulphanilamide	230°
XIV	N-*p*-sulphonamidophenyl-4-(*p*-aminopheny'sulphonimino-chelidamic acid	163°
XV	N-*p*-sulphonamidophenyl-4-(*p*-aminopheny'sulphonimino-1 :4-dihydropyridine	210° (decomp.)
XVI	Pyridine-2 :3-dicarbo-N^1-diacetsulphanilamide	308° (decomp.)
XVII	N-(N^1-sulphanilyl)-dihydrocollidine-dicarboxylic acid	above 300° (decomp.)
XVIII	N-(N^1-acetsulphanilyl)-chelidamic acid	227° (decomp.)
XIX	N-(N^1-sulphanilyl)-chelidamic acid	255° (decomp.)

(VIII), (IX), (XI) and (XII), respectively. (SA) reacts with the pyrone and keto oxygen of chelidonic acid in preference to its carboxylic groups yielding (XIV) which on decarboxylation yields (XV).

When (ASCl) is condensed with (*b*), product (XVII) is formed by the elimination of HCl and simultaneous hydrolysis of acetyl and ester groups which are made apparent by the formation of ethyl acetate as a reaction product. Product (XVIII) is formed by the condensation of (ASCl) with (*c*) in pyridine and is hydrolysed to (XIX). The presence of 'NH'$_2$- in products (XIV), (XV), (XVII) and (XIX) has been proved by diazotisation and coupling.

When the potassium salt of *p*-acetaminobenzenesulphonamide is condensed with the acid chlorides of (*f*) and (*a*) the compounds (XIII) and (XVI) are formed respectively.

Full paper will be published elsewhere.

B. C. JAIN
B. H. IYER
P. C. GUHA

Organic Chemistry Laboratories,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 4-9-1945.

[1] Koloff and Hunter, *J. Amer. Chem. Soc., 62,* 1646, 1940.
[2] Daniels and Iwamoto, *J. Amer. Chem. Soc., 62,* 741, 1940.
[3] Hykes *et al, Compt. Rend. Soc. Biol., 126,* 635, 1937.
[4] Gray *et al, Biochem. J., 31,* 724, 1937.

A NOTE ON THE INVESTIGATION OF RADIOACTIVE MINERAL *VIZ.*, ZIRCON, TO DETERMINE ITS GEOLOGICAL AGE

THE hafnium content of the mineral zircon from Travancore has been found out by three independent methods of which two are physical and the other, a chemical one. Although the chemical method is the most accurate one the results obtained by three methods namely, (*a*) Density method,[1] (*b*) Polarimetric method[2] and (*c*) Ammonia estimation of the double flourides of zirconium and hafnium, agree fairly well and the percentage of hafnium as hafnium dioxide is about 1%.

The amount of lead present in the mineral has been estimated by Dithizone method and has been found to be ·006—·007%.

The complete chemical analysis of the mineral gives the following results:

SiO_2	32·97%
ZrO_2+HfO_2	65·06
CaO	00·30
Fe_2O_3	00·26
Al_2O_3	1·30
Total ...	99·98

It has been found that the mineral is very feebly radio active and so attempts were made to estimate the uranium content of the mineral by means of flourescence of uranium with NaF[3]. Qualitatively uranium was detected but thorium was absent. As the uranium content is extremely small and the chemical method ineffective, we are now trying to determine the quantity of uranium by radio-active method and further work is in progress.

BARUN CHANDRA HALDAR
P. B. SARKAR.

Inorganic Chemistry Laboratory,
University College of Science & Technology,
92, Upper Circular Road,
Calcutta, 21-9-1945.

[1] Hevesy and Berglund, *J. Chem. Soc., 125,* 2372, 1924.
[2] Grant Vernimont and Thomas De Vries, *J. Am. Chem. Soc., 57,* 2386, 1935.
[3] Hernegger and Bertakarlik, *Sitz. ber. Wiss. Wien., 124,* 217-26, 1935.

CONCENTRATION OF RADIOACTIVE PHOSPHORUS (P^{32}) FROM CARBON DISULPHIDE

P^{32} having a convenient life period and giving out β-rays of considerable energy has been extensively employed in biophysical works. Many investigators have directed their attention to its preparation and concentration from S^{32} by neutron proton reaction.

Hevesy[1] first employed carbon disulphide as a convenient source for the preparation of radioactive phosphorus. A few mgm. of yellow phosphorus was dissolved in carbon disulphide before irradiation and after a few days of bombardment the CS_2 was distilled off and the phosphorus in the distilling flask was oxidised and finally converted to Na_2HPO_4 for tracer studies. Hevesy's method consists in the first place of a distillation and secondly a rather tedious process of estimation of the normal P used as carrier for the purpose of a quantitative study. The other methods[2] namely the collection of the active product in the precipitate and the oxidation of P to H_3PO_4 and subsequent extraction with water also requires a quantitative estimation of normal P used as a carrier. The electrical deposition method of J. Govaerts[3] cannot be used in biophysical tracer studies because of the possibility of the electrode material coming out as impurity along with the active deposit during its collection from the electrode.

In view of these difficulties the present authors tried to concentrate active P^{32} from CS_2 by avoiding the use of normal P as carrier in the way used by others.

One litre of CS_2 was taken in a flat bottomed litre flask and the source (40 mgm. Ra + Be) encaged in a glass tube which runs through a cork fixed at the mouth of the flask was placed at the centre. After irradiation for a few days, the source was removed and the radio phosphorus formed was oxidised to H_3PO_4 by adding a few drops of bromine. A few c.c. of standard phosphoric acid was then added and the mass was thoroughly shaken. The H_3PO_4 was afterwards extracted with water. Four extractions, each with 75 c.c. of water, were required to remove all the activities from carbon disulphide. The aq. extract was evaporated and neutralised with standard NaOH solution to mono, di, or tri-sodium phosphate as may be required. The number of counts per minute were as follows:—

Days		Counts/min.
8	...	... 1,600
16	...	... 2,650
21	...	... 3,375

The data fit well with the theoretical time *vs.* yield curve which is hyperbolic in nature.

The special features of this method may be stated as follows:—

(*a*) A complete and easy removal of radio phosphorus from a large amount of CS_2 within a short time (1 hour).

(*b*) The amount of normal phosphorus is known without taking the trouble of estimation which saves time and loss of radio phosphorus involved in analysis.

(*c*) A preparation of any desired sp. activity can be obtained.

(*d*) The product is practically free from organic matter and other impurities that might interfere with biophysical studies.

The details of the work will be published elsewhere.

In conclusion the authors express their sincere gratitude to Prof. M. N. Saha for his kind interest and encouragement. Thanks are also due to Prof. P. Ráy for many helpful discussion and criticisms.

N. N. Dasgupta
B. C. Purakayastha
S. N. Ghoshal.
B. B. Sen.

Biophysics Department,
University College of Science,
Calcutta, 28-9-1945.

[1] Chievtz and Hevesy: *Nature, 136,* 754, 1935.
[2] (*a*) Maier-Leibnitz: *Angew. Chem., 51,* 545, 1938.
(*b*) O. Erbacher: *Physik. Chem., B 42,* 173, 1939.
(*c*) D. E. Hull: *J. A. C. S., 63,* 1269, 1941.
[3] J. Govaerts, *Nature, 141,* 871, 1938.

A NOTE ON THE SECONDARY ASSOCIATION OF CHROMOSOMES AND THE BASIC NUMBER IN *CORCHORUS CAPSULARIS* WILLD

Nandi[1] (1937) reports that in *Corchorus capsularis* the maximum association of secondarily associated bivalents in metaphase I is two groups of two bivalents, the other three remaining separate and consequently suggests that the basic number in *C. capsularis* is 5 and the present number n=7 is secondarily balanced. He also mentions that the cultivated varieties of jute are usually regarded as diploids without giving adequate cytological evidences in favour of such a contention.

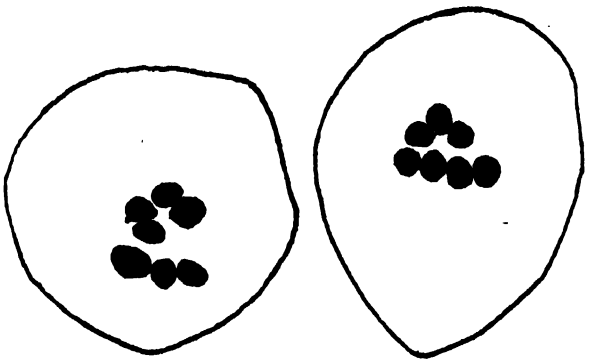


Fig. 1 Fig. 2

Metaphase I showing secondary association of bivalents (×3000) [Drawn with a camera lucida at table level]

In course of cytological investigations in *Corchorus capsularis* the author made some interesting observations. It has been found that an association of two groups of two and one group of three bivalents (Fig. 1) is quite common in a large number of mother cells, but the maximum association observed in a few cases is one group of four and another of three bivalents (Fig. 2) indicating that the basic number is 2.

From a critical study of the morphology and number of nucleolar chromosomes and the nature of secondary association it appears that the basic number in *C. capsularis* is 2 and not 5 as suggested by Nandi (1937). This will be dealt with in detail in a subsequent paper.

In the explanation of Fig. 2 showing the metaphase of *C. capsularis* Nandi (1937) describes the pairs of bivalents to be 'secondarily attached', but attachment of bivalents in metaphase goes against the fundamental conception of the theory of secondary association.

Jayanta Kumar Ganguly.

Cytogenetical Laboratory,
Bose Research Institute,
Calcutta, 1-10-1945.

[1] Nandi, H. K., Trisomic Mutations in Jute. *Nature, 140,* 973-974, 1937.

THE RAMAN SPECTRA OF ACETONE AND DIETHYL KETONE IN THE SOLID STATE

In continuation of our investigations[1] on the Raman spectra of organic substances in the solid state at low temperature the Raman spectra of acetone and diethyl ketone have been studied in the solid state at about $-170°C$ and in the liquid state at room temperature. The results obtained are given in Tables I and II.

TABLE I
ACETONE

Liquid at room temp. Δ ν in Cm^{-1}		Solid at about 170°C Δ ν in Cm^{-1}	
392	1 ; e	95	(1b) ; e ?
487	0 ; e		
528	(3) ; e, k		
790	(10) ; e, k	800	(3) ; e, k
903	(0) ; e, k		
1062	(1) ; e, k	1062	(0) ; e, k
1222	(2) ; k		
1425	(4b) ; e, k	1430	(1) ; e, k
1705	(5) ; e	1702	(1) ; e
2690	(0) ; k		
2857	(0b) ; e, k		
2923	(10) ; e, k	2925	(5) ; e, k
2964	(3) ; e, k	2976	(3) ; e
3006	(3) ; e, k	3008	(3) ; e

TABLE II
DIETHYL KETONE

Liquid at Room temp. Δ ν in Cm^{-1}		Solid at about 170°C Δ ν in Cm^{-1}	
		95	(2b) ; k ?
404	(3b) ; e, k	417	(1b) ; e
740	(2b) ; e, k		
786	(2b) ; e, k	786	(1) ; e, k
950	(1b) ; e, k	950	(1b) ; e, k
1015	(1b) ; e, k	1005	(0b) ; e, k
1093	(4) ; e, k	1093	(1) ; e, k
1238	(2) ; k		
1271	(0) ; k		
1418	(2) ; e, k		
1460	(3) ; e, k	1460	(1) ; e, k
1704	(5) ; e	1705	(1b) ; e
2891	(10b) ; e, k	2890	(0b) ; k
2942	(10) ; e, k	2918	(2) ; e, k
2988	(6) ; e, k	2948	(4) ; e, k
		2982	(3) ; e, k

It will be observed from Table I that many of the Raman lines of acetone undergo changes in intensity and frequency with the freezing of the liquid. The line 1705 cm^{-1} due to C=O diminishes in intensity considerably in the solid state and the line 528 cm^{-1} disappears completely, although the fainter line 1,062 cm^{-1} is visible in the spectrograms due to both the liquid and the solid state. The lines 790 cm^{-1} and 2,964 cm^{-1} shift to 800 cm^{-1} and 2,976 cm^{-1} respectively in the solid state and the line 1,430 cm^{-1} observed in the solid state seems to be weaker than in the liquid state. All these facts suggest that there is strong association of the molecules in the solid state. It is not certain whether the line 95 cm^{-1} observed in the solid state is a genuine one, because there seems to be a Hg band in this position in the neighbourhood of λ 4046. In the case of diethyl ketone also, the lines undergo changes with the solidification of the liquid. In this case the lines due to C–H vibrations undergo considerable changes. The line 1,418 cm^{-1} disappears completely and the line 2,891 cm^{-1} is split up into two lines at 2,890 cm^{-1} and 2,918 cm^{-1}. Also the line 404 cm^{-1} shifts to 417 cm^{-1} in the solid state. These facts suggest that the molecules are strongly associated in the solid state through hydrogen bonds.

These results as well as those obtained with higher ketones will be discussed in a paper elsewhere.

S. C. SIRKAR
B. M. BISHUI

Physics Department,
University College of Science,
Calcutta,
and
Indian Association for the
Cultivation of Science,
Calcutta,
2-10-1945.

[1] Sirkar, S. C. and Bishui, B. M., *Proc. Nat. Inst. Soc.*, 9, 287, 1943.

EFFECT OF VERNALIZATION AND PHOTOPERIOD ON LATE SOWN AMAN PADDY—II

An earliness of flowering in rice by short photoperiodic treatments have been recorded by Alam[1] and more recently by Sircar[2,3], Sircar and Parija[4], Kar and Adhikary[5]. Kar and Adhikary also recorded a lateness in long photoperiodic treatments in a number of varieties sown in the normal sowing time, the plants being exposed to long light treatments when they were 68 or more days old. Authors[6] observed that in Bhasamanik paddy, presowing low temperature treatment and exposing the seedlings is to short photoperiods delayed flowering, when sown late in September. The effect of exposing the late sown seedlings to long photoperiods is reported here.

Four high yielding varieties of Aman, *viz.*, the medium maturing Bhasamanik and Indrasail and the late maturing Kumargar and Tilkachary were tested. The seeds were sown on 15th September in flat earthenware pots with two replicates per treatments. Exposure to longer light period was given from a 500 c.p. electric bulb at a distance of 1 m. commenc-

ing before sunset, making up a total photoperiod of 16 hours a day for one month. The seedlings were then transplanted to suitable earthenware pots, there being 5 pots per treatment and 4 plants per pot. Emergence of first ear was taken as the date of flowering. The results are given below:

Variety	Treatment	Date of flowering	Vegetative period (days)	Difference Control and Treated
Bhasamanik (medium)	Control	17 November	63·12 ± ·62	+6·96*
	Treated	10 November	56·16 ± ·36	
Indrasail (medium) ..	Control	8 November	54·20 ± ·41	+1·93*
	Treated	6 November	52·27 ± ·59	
Kumargar (late) ..	Control	19 November	65·55 ± ·38	+5·79*
	Treated	14 November	59·76 ± ·62	
Tilkachary (late) ..	Control	12 November	58·17 ± ·26	+0·53†
	Treated	11 November	57·64 ± ·29	

* Significant at 1% level.
†Significant at 5% level.

If the controls of the different varieties are compared it is seen that in the late sowings, the usual difference in flowering time is not always maintained, *e.g.*, the late maturing Tilkachary flowered earlier than the medium maturing Bhasamanik. Exposure to long photoperiods tend to induce early flowering in all the varieties. The earliness is very small and insignificant in Indrasail and Tilkachary and more pronounced in Bhasamanik and Kumargar. Deterioration of vegetative growth and general vigour reported in the case of plants exposed to short photoperiods[6] were not observed in the present cases of exposure to long photoperiods. The results indicate that in the late sowings of Aman paddy, when the plants are normally exposed to photoperiods of less than 12 hours, long photoperiods in seedling stage tend to induce early flowering.

J. C. SEN GUPTA
NIRAD KUMAR SEN
Botany Department,
Presidency College,
Calcutta, 2-10-1945.

[1] Alam—Scientific Report of Rice Research Station, Sabour, Bihar, 1940-41.
[2] Sircar, S. M.—*Journ., Ind. Bot. Soc., 41*, 1942.
[3] Sircar, S. M.—*Nature, 378*, 1944.
[4] Sircar, S. M. & Parija, B.—*Proc. Ind. Sc. Con.*, 1945.
[5] Kar, B. K. & Adhikary, A. K.—SCIENCE AND CULTURE, *506*, 1945.
[6] Sen Gupta J. C. & Sen, Nirad Kumar—SCIENCE AND CULTURE, *556*, 1944.

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PLANNING OR MUDDLING ?

EVER since the Indian National Congress started the National Planning Committee, planning has become a catchword and a slogan in India, and within the last two years, the country has been flooded with any number of plans, from all quarters. There are plans by syndicate of capitalists like the Bombay Plan ; plans by persons obviously aspiring to be ministers or obtain some high ministerial job ; plans by private enthusiasts, and plans by Government officials. The latest is the Bengal Government Plan which has been issued in the form of a book from the Government Secretariat. It is not stated how this plan was evolved, but evidently its authorship is for the most part to be ascribed to the members of the Indian Civil Service, who, in the absence of the popular ministry, are now running the Government of Bengal. They might have employed a few scientists and technicians, but evidently the Civil Service provided the philosophy and the direction.

Such enthusiasm for planning is highly commendable, for out of continued discussions emerges wisdom. But it is necessary that some criteria or directives should be laid for the guidance of the planners, for incomplete, hollow or one-sided plans, as many of the plans before us appear to be, are worse than none at all. They only darken the counsel.

Probably the following may serve as proper directives to planners:

(1) Every plan must be total ; *i.e.*, it must not confine itself merely to one aspect of the Nation's activity such as agriculture or primary education, but should embrace all aspects: agriculture, industry, education in all stages, public health, food, shelter, defence, communications, distribution of wealth, labour, employment, social service, and movements of the people, and probably a few more items.

(2) Every plan must give a clear objective analysis of the present situation in all the aspects of Nation's life as given above.

(3) The plan must aim at a definite target to be reached within a specified period of time, and shall state the methods, administrative and financial, by which they hope to reach the target.

(4) The schemes proposed should be arranged in the proper order of priority.

Most of the plans so far produced fall far short of the criteria laid down here.

The Bengal Plan is no exception. As will appear from a summary of it given in a subsequent article by Mr T. K. Basu, the plan gives no objective picture of the present situation in Bengal. It deals only with a few aspect of the Nation's activity. In the words of the plan itself:—

"There are some obvious gaps in the plan. There are no schemes for town-planning, for hydroelectric or thermal power development (except for a survey of such resources) for industrial planning except as falls within the scope of the provincial government, though some of them, except power development are under consideration."

These are not gaps, but yawning chasms!

Regarding the objective the plan says:

"The object of the plan is to raise the standard of the common man, to promote his well-being and to provide, incidentally for the task immediately ahead,—the resettlement of the returned soldier. Agriculture is the backbone of rural economy, indeed of Indian economy. Hence, any plan for raising the standard of living in India must necessarily concern itself predominantly with raising the standard of living of the inhabitants of her 660,000 villages, that is, with the development of her agriculture. So it is with Bengal".

This is the central idea of the plan and a rather catching idea for the uncritical reader and looks curiously like the Gandhi-Agarwal-Kumarappa plans in its insistence on village life, agriculture, and

omission of industries ; measures of improvement of education, transport, irrigation, communication, waterways and administration which have been proposed are all incidental to the central idea.

The plan entirely ignores higher collegiate and University education, probably because they are connected with town life. Higher technical and industrial education are also ignored, except a casual reference to a scheme for the improvement of the Bengal Engineering College at Sibpur which is said to be on the way, but the contents of the scheme are not disclosed.

In spite of the professed sympathy with the objects of village improvement, there is neither any analysis of the conditions of village life nor recommendation of any specific measures for the improvement of these conditions. We wonder if any of the authors of the plan has ever seen the inside of a Bengal village. Let us give a realistic picture.

The average density of population per square mile in Bengal is 750, and in some districts it exceeds 1200. It is admitted by all economists that a countryside, however rich it may be, and however best land and water may be utilized, cannot yield a decent standard of living to more than 250 per sq. mile.

About two-thirds of the adult village population have no employment. The villages are extremely crowded, houses are ill-constructed, good drinking water is not available, sanitary arrangements are extremely faulty, so that a townsman cannot pass through a village without having his nose perpetually plugged up by a handkerchief. There are no common grounds for the meeting of the people and there are very few entertainments.

According to an analysis by Prof. K. P. Chattopadhyay, full 74 per cent of the population depends on agriculture, yet they cannot produce sufficient food for Bengal alone, while in the U. S. A. and other advanced countries, 12 per cent of the population is sufficient for agriculture, for the production of food, and cash crops, like cotton, oil seeds, soya bean etc.

It is clear therefore that if the Bengal Government really intends to bring any relief to the Bengal villager, it must provide at least half the village population with a new kind of activity, other than agricultural. This can only be by the creation of all major industries for which there is scope in this province. A plan which ignores Industrial Development completely and gives priority number five to *power development* which is the key to all industrial development as this plan does therefore labours upon a wrong analysis of the situation and pursues a barren philosophy.

The present industrial position of Bengal (in fact, the argument can be applied to India as a whole), may be guessed from the per capita consumption of energy in all forms. It comes to about 10 units of electrical energy, and 15 units of thermal energy. The energy index, which is largely manual, cannot exceed 100, whereas in all modern countries, it varies from 2000 to 3000 units. The annual income of the average Indian is therefore 20 to 30 times less than that of a European. The conditions of the villages have scarcely advanced beyond medieval times, they have become more crowded and the large artisan classes formerly forming a large part of the village population have been completely pauperized by the inroads of foreign industry.

If the country is to have a decent standard of living, planning must be concentrated on development of major industries and industries on agriculture, but the authors of the Bengal Plan have given very cursory attention to industries.

Nay, the Bengal Plan has not even tried to find out why industries based on agriculture, for which the soil of Bengal is highly suitable have not flourished here. One may point to sugar (of which 80 per cent comes from outside Bengal), paper (of which we expect an enormous increase if a drive for stamping out illiteracy be instituted), textiles (about a hundred mills are required to clothe Bengal) and chemical pulp for rayon (of which raw materials can be grown in the Himalayas), oil seeds which are in a dacadent state in Bengal. Chemical and metallurgical industries have advantages for Bengal which are enjoyed by no other province in India but not much use has yet been made of such advantages.

Bengal's River System

The Bengal Plan says :—

"Bengal's extensive river system is unique in the world and the development of its potentialities to the fullest must form an integral part of any plan of post-war development. Elsewhere, proposals for harnessing the waters of Bengal for the production of hydro-electric power and for irrigation have been considered. Its importance as a means of communication to the community, to the villager in particular, in eastern and southern Bengal is perhaps even greater. Not only does water provide the cheapest means of transport a consideration of prime importance to the villager—there are several important trade marts in southern Bengal with which it provides the only means of communication."

But in spite of expression of such fine sentiments, we have looked in vain in the pages of the Bengal Plan for any analysis of the present condition or any concrete measures for the full-scale development of Bengal's river system except for the Damodar Valley, and the More River scheme, which have been discussed later. The Bengal Plan has not even remotely mentioned any other comprehensive river-development scheme. The omission may be partly due to the fact that we have very scanty knowledge regarding Bengal rivers ; their discharge throughout seasons and years, the physical and geological data of their basins are only roughly known. In the absence of these data, whose compilation has been emphasized by successive genera-

tion of engineers called upon to build bridges and railroads over Bengal Rivers, no scientifically sound scheme can be prepared.* The clear duty before the Bengal Government was to give special priority or priority No. 1, for the establishment of a fully fledged Hydrological Department, whose duty would be similar to that of the Bureau of Reclamation in the U. S. A.,—intensive study of rivers and their basins, collection of data, planning of model experiments, and fundamental laboratory experiments, without which no planning is possible and when such data have been collected, framing in co-operation with other departments of the Government, comprehensive plans for multipurpose and full development of the whole river system of Bengal. This department of hydrological research should be separated from the Irrigation Department whose personnel are too much pre-occupied with routine duties, and have neither the time nor the training to carry out such vital researches.

The authors of the Bengal Plan probably do not realise that the success of all their schemes depend upon the evolution of a proper system of management of Bengal's rivers for Bengal's life more than that of Egypt, is tied up with her rivers.

They have laid great stress on the construction of roads, national and provincial highways. Roads are a great necessity for Bengal, but past experience ought to have been sufficient warning for the Bengal Planners that roads and railways, planned without any reference to the river system, are likely to obstruct the free flow of water, cause the formation of malarial swamps, as had happened all over Bengal. The devastation of Burdwan by malarial epidemics between 1860 and 1870, outbreak of malaria in the districts of Central and Northern Bengal have been rightly ascribed to the construction of railways and roads without reference to the river system of Bengal. Sometimes the rivers take their revenge, by frequently breaching such railways and roads as has frequently happened in the Damodar Valley or was going to happen in the case of the Hardinge Bridge at Sarah over the Padma in 1932, which was saved only at an expenditure of two and half crores of rupees.

Planning of roads and railways should therefore come after the river-training measures have been evolved and agreed upon. The Bengal Plan therefore proposes to do things all in the wrong way.

We understand from the Bengal Government Plan that the present plans are all tentative and they would be submitted to a Development Board, consisting of a Commissioner for reconstruction and a number of secretaries of the Government Departments. But under the present system plan-making is being done almost completely in the wrong way. The task is distributed over the different ministries, who entrust the work to their officers, who have other routine work to do. They are sometimes assisted by Committees composed of legislators, a few scientists and technicians who occasionally meet. The ministers who have constantly to fight for their life, have hardly any interest in plans which take years for completion, and which can not be taken for immediate execution during their regime. The officers are mostly by training and habit hardly fit for scientific planning, and non-official members hardly take their work seriously. The result is a patch-work like the present one. It is, therefore, suggested that if the Government really mean business, they should have a *Permanent Planning Commission* consisting of scientists and technicians, which

* Sir F. Spring who planned the Hardinge Bridge at Sarah about 1905, wrote in his 'River Training and Control':

"As trustees of so fine a property as this—canals and railways, it might not unreasonably be expected that the State would see the importance of devoting a comparatively small annual appropriation to original research, on lines likely to be productive of a good return for the expenditure, in the form either of reduction in the first cost of its public works or of their safety and their economical upkeep when built. Heretofore there has been no pretence of organizing any such research in connection with the engineering of the canals and railways of India. Engineers have gone on blundering, benefiting, rather by chance than by design, by the experience of their predecessors, and each considering himself lucky if he escapes disaster at the hands of the tremendous forces of Nature—amongst which some of the most potent for good or evil are the great rivers—with which he has to struggle."

* * * *

"They ought not, nor ought the State, to lose sight of the importance of endeavouring, by consistent, logical and well organized research, to learn something more definite than is now known about the physics of long reaches of rivers. A perusal of Chapter III and XXI, as well as of Mr R. A. Molloy's Technical Section paper No. 118, will suffice to show how blindly, heretofore, in the interests of the residents on their banks, men have been fighting against the ill-will of some of the great rivers; whether on behalf of the maintenance of levees (this is a word of French origin, which is used in the U. S. A. to denote embankments), whereby devastating floods are excluded from great inhabited areas; or for the conservation of the heads of inundation canals on whose integrity the welfare of many thousands of people is dependent; or in the interests of riparian cities whose obliteration would be a blot on the administration of civilized and intelligent rulers. It is difficult to avoid the conclusion, after perusal of Chapter XXI, that for lack of adequate knowledge, the engineers concerned with the interests of the inhabitants of the valley of the Indus have been obliged to work more or less in the dark in their fight with that river, and to make matters worse it has constantly happened that, owing to the climate, to the exigencies of public service, no sooner does one engineer get some small inkling of the tricks than he is replaced by one with all his experience to gain; and in six months he, in turn, is replaced by somebody else whose experience of the river has perhaps been limited to crossing it. How, under so haphazard a system, anything gets done at all is a marvel; and instead of being surprised at £100,000 worth of work having been wiped out, the State may congratulate itself if the loss is not double. However there is always the satisfaction, in the case of such expenditure as that dealt with in Chapter XXI, that the whole of the money has remained in the country, and that if the tax-payer takes money out of his coat pocket only to put it into his waistcoat pocket he can always pick it out again, or its equivalent."

would be an autonomous organization, independent of any ministry. This policy has been followed in Russia, where the State Planning Commission is not under any People's Commissars, but is an independent organization with very large powers, responsible only to the Supreme Cabinet. All important research institutes including the Hydrology Department should be directly under the State Planning Commission, which should go on with its labours independent of the fates of ministries.

How to Regenerate the Rural Areas of Bengal

The Bengal Plan is not altogether without a few redeeming features. It has a few good words to say in favour of the schemes for the rehabilitation of the Damodar Area, but the credit for suggesting the scheme hardly be claimed by the Bengal Government. As readers of SCIENCE AND CULTURE are aware Government has spent in the past enormous amounts of money in vain attempts to curb the fury of this river within embankments, but it was not able even to achieve the narrow objective of protecting railways and roads, though it went to the length of sacrificing the health and prosperity of the population in the basin. But it was pointed out in the columns of SCIENCE AND CULTURE that the Damodar can be developed, on the multipurpose basis, like the Tennessee, for prevention of flood, generation of power, for perennial irrigation of nearly one million acre of land, and possibly for navigation as well. The Government called a Tennessee Valley expert, Mr Voorduin to examine the suggestions made by the Damodar Enquiry Committee, and he has submitted his reports, which is just now released. If the readers of SCIENCE AND CULTURE care to peruse the report they will find that the Tennessee Valley expert has endorsed everyone of the proposals made in our articles and has worked them out in greater detail, and thanks to the interest taken by the Hon'ble Dr B. R. Ambedkar, Labour Member in the Viceroy's Cabinet, the schemes are fairly on the way. If the scheme is given effect to, the lower Damodar Valley, including the present malaria-ridden swamps of Burdwan, and Hooghly, to the west of Calcutta will undergo a complete regeneration. What will that be like? Let us tell our readers an anecdote.

Village *Vs.* Urban Life in England

In course of the recent tour of the Indian Science Mission in England some of the members were once motoring from Manchester to London with an English Civil Servant, Mr Harley, as their guide. While passing through some middle English country towns and villages, they requested their companion to show them some typical English villages. He said 'You are just passing through some typical villages'. But some member told him that these did not at all look like villages in their country. 'What is a village like in your country?' asked he. They said 'a typical village in their country is one which on the average is 20 miles from the nearest railway or steamer station, a village would be lucky if the nearest medical consultant could be found nearly 4 miles away, there would be hardly one school in ten villages and people would have to draw water from wells, or waterpools, all houses would be of mud and bamboo, and the countryside would be generally a malarial swamp, there would be no question of telegraphic, telephonic or electrical, steam or gas or motor service.' The Civil Servant replied 'We have read of such villages in our history books, but whether any such village still exists in the British Isle should probably be referred to an archaeologist.'

This story will probably convey some idea of the profound changes which have been brought over the British countryside as a result of application of science within the last hundred years. About a hundred years ago, the English villages were probably not much better than our own villages at the present time. One can easily find what an old English village was like from the vivid pen pictures of Charles Dickens or Westaway's "The Eternal Quest". But as a result of the English grid system, which supplies cheap power to the remotest corners of the country, even remote villages have electrical power, and central heating. Most English villages have got telegraphic and telephonic services, are connected by well laid out roads, so that almost every place can be reached by motor car, though it may not be situated on the railroad. In fact, the whole of England is becoming one vast city, everywhere all comforts of town life are available. The Britishers, West Europeans and Americans have thus solved, thanks to science, the contradiction which still exists in this country, between cities and villages. This is the result of twenty-five years of intense constructive work in Road and Electrical Power development. England is now covered with a network of power stations, distributed all over the country, which enabled the Britishers during the present war to remove many of their essential productive industries from big cities to the countryside, and thus maintain production at high level in spite of intense bombing of big cities. Probably, as a result of the advent of the Atomic Age, this process of dispersal of population into country areas would further be accelerated, for huge cities like London can be entirely wiped out by a few atomic bombs, either directed from aircraft or distant stations, but if the population and productive centres are dispersed over wide areas, the destruction would be far less. The day of big cities appear to be doomed.

Let us hope that the Damodar project, which has been undertaken by the Government of India,

and the More River project to which the Bengal Plan gives special priority will be pushed through energetically. It is desirable that the Government cut through the red tape to some extent, for in India projects have a tendency of wandering amongst the files for a long time till they are either lost, or emerge out in strangely mutilated forms after the public have forgotten all about them. Even after a plan is sanctioned, enormous times are consumed in execution *e.g.*, the Mettur dam in Madras took seven years to complete. We have much to learn from the U. S. A. in this respect, for in the Tennessee Valley, 21 multipurpose dams, almost each one bigger than the Mettur, and costing nearly 700 crores of rupees were constructed within 11 years.

Hydro-electric Power-development Schemes in other Parts of India

While the Bengal Government has thus ignored serious industrial planning almost completely other provincial governments are seriously pushing on with their industrial plans. A few examples are given.

The Punjab.—The Government of the Punjab has got a vast plan for the development of the rivers within its boundary on a multipurpose basis. It is well-known that the Punjab has been covered during the last 50 years with a network of irrigation channels which has converted a semi-arid land into one of great agricultural productivity. Each of the five rivers has got 3 barrages upon it, no water is allowed to be wasted in the desert and perennial irrigation enables the Punjab peasant to grow two to three crops in the year. But though these rivers could be developed for hydroelectric power, no scheme had been undertaken upto 1924, when the Uhl river scheme, was started. This was an ill-conceived and ill-executed plan, and taught by this example the Punjab Government is giving more systematic attention to hydro-electric development in recent years. The following dams have been projected and some of them are in course of construction :

(1) Dam over the Tons and Giri tributaries of the Jumna, which will be the highest in the world.

(2) The Bhakra Dam over the Sutlej which will be about 700 ft. high.

(3) The Riasi Dam over the Chenub and a Dam on the Jhelum river just before it debouches into the plains of the Punjab from Kashmir.

It is expected that all these projects—when fully developed will give to the Punjab a total power of 3 million K.W. and an energy output of about 15,000 million K.W.h. in the year. If these projects are completed the Punjab will have nearly 600 units of electrical energy per capita and will be the richest province in India, both in industry and agriculture. The Punjab Government has engaged the services of Mr Savage of the Bureau of Reclamation, America, who has vast experience in the building of multi-purpose dams as Consultant and has already ordered electrical machineries for a number of dams. They have sent to the U. S. A. five of their engineers to be trained in the laboratory of the Bureau of Reclamation at Denver.

Madras.—In the Madras Presidency, thanks to the initiative taken by the late Government and particularly by the present Chief Adviser Sir Rammurthy and Chief Engineer Mr G. R. Aiyangar, a vast number of river improvement schemes have been undertaken. The Godavari scheme alone is expected to yield nearly 300,000 K.W. of power. Work has already been started on the Tungabhadra scheme. In fact, though details are not yet available, it is known that the Government of Madras have plans of covering the whole presidency with a network of electric power lines, which will be helpful in the creation of industries and bring prosperity to the rural side. In view of the great demand for engineers which will be needed for these schemes, the Madras Government has taken serious steps to bring into existence, three more first-grade engineering colleges at Coimbatore, Waltair and Annamalai in addition to the existing college at Guindy, in the suburbs of Madras, which has so far satisfied the needs of the whole Presidency. The Pykara scheme and the Mettur scheme are already giving 35,000 K.W., and when fully developed are expected to reach a total of 137,500 K.W.

Travancore.—The Indian province of Travancore has an area of about 6000 sq. miles and a population of about 6 million. It is one of the most densely populated parts of the world. Formerly matters were allowed to drift, and due to the shortsightedness of previous rulers, all land above 4000 ft. were perpetually leased to a foreign company for an annual sum of Rs. 50,000. Under the inspiring guidance of Dewan Sir C. P. Ramaswamy Aiyar, this little State has been galvanised into action. The Papanashan and the Pallivasal schemes are already giving 18,000 K.W. and a Fertilizer Plant which will yield about 50,000 tons of ammonium sulphate per year is being installed. Mr K. P. Menon, Chief Electrical Engineer, was recently in the U. S. A. on a mission to buy electrical machinery for the projects and also machineries for industries which are being established in the State under the State patronage. They include fertilizers, rayon, paper and chemicals. The Travancore State ultimately hopes to develop about 300,000 K.W. which will give them annually about 2000 million, K.W.h that is about 300 units per head. These projects, when they are carried out, will make Travancore as rich as many parts of Europe.

Mysore.—The Indian State of Mysore has been the pioneer in the development of electrical power and use of river water for irrigation. Long before these ideas had seriously engaged the attention of our rulers in British India, Dewan Seshadri Aiyar of Mysore got American experts who had knowledge of the development of hydro-electric power in the Niagara Falls to develop the potential resources of Cauvery river and the result was the installation of the hydro-electric station at Sivasamudram in 1902, which has now developed about a power of 50,000 K.W. The Government of Mysore has since been planning the installation of hydro-electric plants on the Jog Falls in the Western Ghats and a station on the Shimsa tributary of the Cauvery at Shimsapur and at other places. The Shimsa has already been developed to 20,000 K.W. and the Jog falls are planned to develop 48,000 K.W., but ultimately to 96,000 K.W. Ultimately all these stations are expected to raise the total power installation of Mysore to about 2 0,000 kilowatts, yielding yearly 1200 million K.W.h., or nearly 300 units per head. Dewan Visvesvaraya constructed the Krishnarajsagar barrage over the Cauvery with the idea that every drop of water which falls in the Mysore plateau will be kept there and used for agricultural and industrial purpose. The effect of all these enterprises on the part of this premier Indian State has been to increase substantially the material prosperity of Mysore over the surrounding parts of British India and when all the schemes now in hand are carried out, Mysore will probably attain standard of living comparable to many advanced parts of the world.

Bombay.—In the Bombay Presidency hydro-electric power has developed through the enterprise of the great J. N. Tata about the beginnings of the present century. The waters precipitated on the Western Ghats, are collected in reservoirs and made to run hydro-electric plants at the three stations, Khopoli, Andhravalley and and Bhira (Tata Hydro-electric Power). These three power stations have solved to some extent the power problems of the industrial city of Bombay and has given her for sometime supremacy over all other manufacturing cities of India. Recently, the Bombay Government has engaged the services of a number of hydro-electric engineers to completely survey the resources and develop them as far as possible. The Koyna River, in the southern part of the Bombay Presidency is expected to yield about 300 thousand kilowatts and is being studied and surveyed with a view to power development.

Not much information is available regarding the projects in the United Provinces of Agra and Oudh and in Bihar, but it is understood that these two governments have taken up seriously the development of the Sone river and its tributaries on the Tennessee river model. The Sone river is capable of half the production of the Tennesse river and if fully developed will give these two provinces about 5000 million K.W.h. of energy. The prospects of the Bundelkhand rivers are also being investigated. But the greatest source of hydro-electric power is to be found in the Ganges and her tributaries round about the Himalayan foot hills, but these do not seem to have been yet properly surveyed.

In Orissa, the Mahanadi and other rivers have a catchment area of 51000 sq. miles, with about 40-50 inches of rainfall. Probably the whole basin can be developed on the Tennessee model, and preliminary surveys are stated to have been ordered by the Labour Department of the Government of India.

This information, which is incomplete, shows that Bengal is at the bottom of the ladder regarding projects of hydro-electric power development and that her civilian rulers have no intention of taking up the problem seriously.

In ancient times, when one people conquered another, they made slaves of the latter. Thus Imperial Rome sold the whole population of vanquished Carthage to slavery. Slavery has been legally abolished, but a modern form of slavery has been introduced in recent years. This is reducing a country to agricultural production only. H. Morgenthau, the U.S.A. secretary for finance gave out last year, that after victory, Germany and Japan will be reduced to agricultural countries, and the policy is now being actively pursued. But in India, the policy has been pursued for centuries, and there is no indication of change of heart or policy, as the Bengal Plan shows. But while British Imperialism does not change its methods or policy quickly, Communistic Imperialism of Russia is just working in the opposite way and has taken up plans for the fullest industrialisation of Central Asian dependancies.

POST-WAR RECONSTRUCTION
(BENGAL GOVERNMENT PLAN—A SUMMARY)

T. K. BASU,
DEPARTMENT OF ECONOMICS, UNIVERSITY OF CALCUTTA

THE Government of Bengal have recently drafted a plan for post-war reconstruction. It is in essence a short-period plan, executable within the first five years but the Government assure us that it contains within it the germs of a long-period plan.

The plan is not a blue-print. It may and perhaps will undergo modification to suit changing circumstances as the plan progresses.

The schemes have been grouped into four classes arranged in order of urgency. Those falling within Class I are intended to be taken up before April 1947 at the latest. Class II schemes will be taken up between April 1947 and April 1950. Those under Class III will be taken up between 1950 and 1952. Class IV schemes should be taken up within the first five post-war years. Certain schemes *viz.*, training of higher technical personnel abroad, establishment of a central livestock research-cum-breeding station, expansion of agricultural research, expansion of Fisheries Department and so on have been granted *special priority*. They are either to be taken up immediately or have already been undertaken.

The announced object of the plan is to raise the standard of living of the common man. It aims primarily at the improvement of agriculture. We are told that the progress of a country is best judged by the progress of its villages and that agriculture is the backbone of Indian economy.

The agricultural schemes are divided under three broad heads: (1) Organization, (2) Research and (3) Land development.

Organization.—The planners propose to provide facilities for the training of personnel in modern agricultural methods. It is expected that at the end of five years there will be one Deputy Director of Agriculture in each circle of two districts, one Agricultural Officer in each of the sub-divisions, one Agricultural Demonstrator and one *Kamdar* in every six unions. The Bengal Agricultural Institute will be expanded so as to turn out 150 graduates annually.

Research.—A comprehensive scheme of research, estimated to cost Rs. 1½ crores in the first five years includes the expansion of existing research sections like agricultural engineering, plant breeding, agricultural chemistry and animal husbandry and the establishment of new research sections namely plant protection, horticulture and agronomy. Research will also include problems of livestock improvement and management and soil survey for obtaining soil maps, soil erosion survey and collection of crop statistics and data.

Land development is sought to be made through such means as irrigation, supply of better seeds and manures, protection of crops against pests and diseases, use of better implements and better livestock and schemes for the utilization of land now lying waste or damaged owing to the incursions of water-hyacinth. The cost during the first quinquennium of the above schemes for land development would be 17 crores 15 lakhs.

The importance of livestock seems to be realized by the Government and it is proposed to increase the staff of Livestock Officers, Assistant Livestock Officers and Stockmen. Animal farms are proposed to be started at Murshidabad, Dinajpur, Chittagong and Darjeeling. A 6000 acre Central Livestock Research-cum-Breeding Station has been sanctioned by the Government to be established at Kanchrapara. The staff of veterinary officers, surgeons and assistant surgeons is expected to cost Rs. 4½ crores during the first five years.

It is of supreme importance that in order to ensure the agriculturist proper price for his produce and to secure the maximum advantage to the community agricultural marketing conditions should be properly organized and improved. The proposals to this effect include the establishment of Agricultural Marketing Intelligence Service, to undertake, *inter alia*, marketing surveys, collection of samples of agricultural produce and prescription of standard grades and qualities, supervision of regulated markets and licensed warehouses, sale of "Agmark" products, introduction of standard weights and measures, assisting co-operative societies and so on. Marketing improvements are expected to cost Rs. 92 lakhs in the first five years.

"A condition precedent to the adequate development of markets is the development of communications" and the scheme to this effect includes a road plan and a waterways plan. The road-plan visualises the construction in about 20 years of (1) 1200 miles of National Highways, (2) 2242 miles of Provincial Highways and (3) 6350 miles of Major District Roads. Regarding waterways, the potentialities of Bengal's extensive river-system seem to be realized by the Government at last and its importance apart from its service as a means of communication is mentioned. The two schemes included in the plan aim at keeping 20 important trade routes clear of shoals and other-

wise navigable throughout the year. The most important irrigation projects are those connected with the Damodar control. The total cost for the improvement of communications is estimated to be Rs. 45 crores.

The planners realize that in any such scheme as they propose, the abolition of Permanent Settlement must take a prominent place. State acquisition will be taken up first in the districts of Bakarganj, Faridpur, Burdwan and Hooghly and the Sunderbans. The Sunderban area acquisition alone is expected to cost about Rs. 26 crores of which 12 crores will be spent in the first five years.

The manifold industrial and domestic possibilities of forest produce are mentioned and a total amount of Rs. 243 lakhs is proposed to be spent on rehabilitation of forests and afforestation.

The schemes for the improvement of the co-operative movement in the Province aim mainly at rehabilitating co-operative credit institutions, providing greater facilities for financing agricultural operations generally and co-operative societies in particular, assisting the rehabilitation of fishermen so seriously affected by the famine, the development of co-operative handloom industry and of co-operative marketing of agricultural produce. Schemes for the establishment of Agricultural Credit Bank are also included. The total cost under these heads is estimated at Rs. 2 crores 58 lakhs. Schemes for the development of fisheries and the prevention of destruction of fry are also proposed to cost about Rs. 1 crore 53 lakhs.

The planners admit that any scheme for comprehensive reconstruction must include the development of industries. But they are of the opinion that steps concerning major industries in the Province 'must await the decisions and action on an All-India basis' and consequently the whole responsibility regarding major industries is thrown on the Government of India.

They have however put forward certain schemes concerning medium and small-scale industries. These fall into the following main groups: Settlement of Ex-service Personnel, Development of Salt Industry, Sericultural Development, Technical and Industrial Education and Organization of the Department of Industries.

Regarding ex-servicemen, it is proposed that several training centres should be started at Calcutta and other places for training them in scientific methods of farming, animal husbandry and cultivation. A scheme is also proposed for their resettlement on land. It is proposed to settle 10,000 soldiers and laskars in 191 blocks covering a total area of 2 lakh acres and 1 block will cover 1000 acres. This will open out the possibilities for experiment in mechanized forms of cultivation and collective farming. The allotment per family of soldiers is thus going to be 20 acres.

Regarding the development of salt industry, they propose to set up a Salt Development Board and to establish a Salt Institute which will collect data. Sericultural development is likewise proposed through the training of village workers, provision of facilities for the maintenance of mother stock and the production of superior seeds, etc.

It is also proposed to establish a 1000 acre farm in the district of Dinajpur as a jute seed multiplication farm.

The 15 schemes comprising the group entitled technical and industrial education aim at reorganizing existing technical institutions and opening certain new institutions with a view to improving the technical and industrial training now given in order to meet the increasing needs of Bengal trade and industry and to stimulate the industrialization of the Province generally.

Reorganization of the Department of Industries involves expansion to enable it successfully to cope with post-war development work and to introduce standard weights and measures.

"In the wake of industrial development come labour problems" and so comes a scheme for the maintenance of harmonious relations between employers and labour and for the amelioration of labour conditions generally. A sum of Rs. 2 crores 36 lakhs is proposed to be spent on the fostering of industries and labour welfare.

The medical schemes aim at the rehabilitation and improvement of existing hospitals and at the rapid expansion of medical facilities in urban and rural areas.

It is further proposed to extend hospital facilities specially in rural areas. There are at present only 6400 permanent beds in moffussil areas to cater to a population of 60 millions (Position = 1 bed for 9375). "The Province requires a minimum of 16,000 beds" (Proposed position = 1 bed for 3658. Western standards = 1 bed for 2,500).

To combat malaria, it is proposed to set up a directorate under a malariologist of international repute and staffed with acknowledged experts. The cost of medical schemes amounts to Rs. 13 crores 50 lakhs.

Regarding education, three schemes deal with the training of trainers of primary school teachers according to the new technique. The total number of schools is set out to be 50,000, the number of teachers 250,000, the capital expenditure Rs. 37½ crores and the recurring cost Rs. 19 crores per year. In the first quinquennium the proposed sum to be spent is Rs. 8 crores.

It is proposed further to increase the grants-in-aid to existing secondary schools and to convert 50 of the best high schools into model schools in the matter of staff, buildings and equipment. The salary of the existing primary school teacher will be raised from the meagre pittance he now gets to a living wage which is to be Rs. 30 for trained matriculates and Rs. 18 to Rs. 22 for other teachers.

The Government Plan states that the successful execution of their schemes presumes "the maintenance of law and order." Hence the inclusion of the schemes for strengthening (1) Police, (2) Jail and (3) District Administration. The total cost of strengthening general administration will be Rs. 7 crores and 57 lakhs.

An attempt has been made to estimate the ultimate net outlay of the Plan. This comes to Rs. 250 crores approximately (capital) and Rs. 31 crores (recurring annual expenditure).

BIRTH CENTENARY OF WILHELM KONARD RÖNTGEN

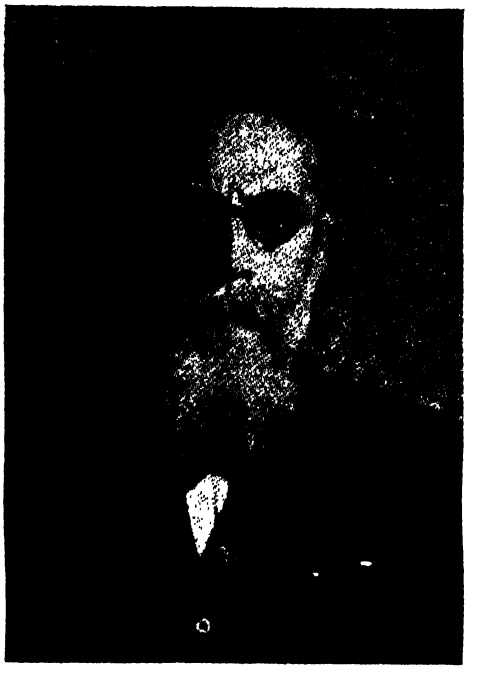
S. C. SIRKAR

CALCUTTA UNIVERSITY

WILHELM KONARD RÖNTGEN, the discoverer of x-rays was born on March 27, 1845. The discovery of x-rays was announced by him in November, 1895. The centenary of his birth and the fiftieth anniversary of the discovery of x-rays have therefore come this year. The discovery is undoubtedly one of the most important discoveries in physics, but the credit of the discoverer tends to be minimised if the discovery is considered to have been made accidentally. It is true that the apparatus with which Röntgen discovered x-rays was not an ideal one for the production of x-rays, but it required uncommon ingenuity and foresight to use a fluorescent screen and photographic plates covered with black-paper to detect the "invisible radiation" which Röntgen suspected to be produced in his Crookes tube. Many other contemporary phycists had been using similar apparatus for their investigations on cathode rays, but all of them had overlooked the "invisible radiation" which must have been produced in their Crookes tubes and caused some disturbances in their normal work. Röntgen believed that such a new radiation was probably produced by the cathode rays and looked for it systematically. Full credit for the discovery of one of the most important fundamental phenomena in Physics should therefore be given to him.

In this connection the recollections of an interview which Sir James MacKenzie Davidson had with Prof. Röntgen are quoted here.

"While travelling on the continent in 1896 I made a pilgrimage to Würzburg, and called at Prof. Röntgen's house in the evening, and was kindly granted an appointment for the following morning. I presented myself about 11 A.M. and was shown into a laboratory which contained a coil and a small cylindrical-shaped x-ray tube. Prof. Röntgen, a tall man with dark bushy hair, a long beard, and very kindly and expressive eyes, received me cordially. He could not speak much English ; I was still worse



Wilhelm Konard Röntgen

at German. However, by means of English and some Latin we made ourselves intelligible to one another. He excited the tube and showed me various shadows on a fluorescent screen. On each of the terminals of his coil he had a small aluminium ball, 1 cm. in

diameter, which he told me he used as an alternative spark gap to test the hardness of the tube. He incidentally remarked that he found a tube had its maximum photographic effect when it was working just at 2·5 cms. alternative spark, a fact which I have always found to be correct. I asked some blunt questions as follows:

Question. "What were you doing with the Hittorf tube when you made the discovery of the x-rays?"

Answer. "I was looking for invisible rays."

Question. "What made you use a barium platino-cyanide screen?"

Answer. "In Germany, we use it to reveal the invisible rays of the spectrum, and I thought it a suitable substance to use to detect any invisible rays a tube might give off."

"He then detailed how he made the discovery. He said he had covered up the Hittorf tube with black paper so as to exclude all light, and had the screen (which was simply a piece of card board with some crystals of barium platino-cyanide deposited on it) lying on a table 3 or 4 metres from where the covered tube was situated, ready to be used. He excited the tube to ascertain if all light was excluded. This was so, but to his intense surprise he found the distant screen shining brightly!"

"I asked him 'what did you think?'. He said very simply 'I did not think, I investigated'."

"Incidentally he told me how he had taken a photograph through a pine door which separated two of his laboratories. On developing the negative, he found a white band across it, which he ascertained, corresponded to the beading on one of the door panels, He stripped the beading off, and found that the band of shadow was due not to the increased thickness of wood but to the 'plumbum' (white lead really) the door maker had employed in attaching the strip of wood."

"He seemed amused at my remonstrating with him about keeping the 'screen' lying about in his laboratory. I told him it was a 'historical screen' and should be preserved in a glass case! I hope he has carried out this suggestion. For the sudden shining of that 'screen' undoubtedly led to one of the greatest discoveries in modern times."

The remarks made by Stokes on the Kelvin Jubilee Steamer regarding the discovery are also interesting. He said "others might have x-rays in their tubes, but it was Röntgen's indubitable claim to have got them through other people's bones!"

Some of the important properties of x-rays were discovered by Röntgen in his preliminary investigations. It was he who first observed that x-rays can affect photographic plates and can penetrate opaque substances. He also observed that the penetration is less in denser materials, and consequently a shadow of the denser material is produced on the fluorescent screen if it is imbedded in a lighter material. He realised the usefulness of these properties in medical diagnosis and communicated the discovery first to a medical society, the Physico Medical Society of Wurtzberg. For the full use of the radiation, however, the scientific world had to wait for more than a decade till some other properties of x-rays were discovered.

During the first decade after the discovery of x-rays the practical use of x-rays was confined to medical diagnosis and surgery, and simultaneously physicists were engaged in investigations on the properties of the new radiation. The methods of medical radiography used in the preliminary stage were so very defective owing to the lack of knowledge regarding the true nature of the radiation that many pioneer workers were permanently injured by undue exposure to the radiation, and the methods used both in radiography and radiotherapy could not be standardised till some new discoveries regarding the important properties of x-rays were made by some physicists. Attempts were first made by some of them to prove that x-rays possess the properties of electro-magnetic radiation, and in 1906 Barkla first demonstrated the polarisation of x-rays scattered by light elements. No accurate method for the determination of wavelength of x-rays was, however, known at that time, and only a suggestion that the wavelength might be of the order of 10^{-8} cm. came from the results of investigations on the diffraction of x-rays by narrow slits. Fortunately, the mathematical theory of space groups in 32 classes of crystals, developed almost simultaneously by the three famous mineralogists, Schönflies, Barlow and Federov, respectively of Germany, England and Russia had been published just before the discovery of x-rays. In 1912, Laue suggested that crystals might serve as suitable three dimensional gratings for the diffraction of x-rays and worked out the theory. The experiment was tried by Friedrich and Knipping at his suggestion and the results confirmed the predictions of Laue's theory that discrete diffraction maxima arranged according to some symmetry would be observed in the diffraction pattern. Neither the wavelengths of x-rays producing the diffraction maxima nor the grating elements in the crystals used could, however, be determined from the diffraction pattern obtained by Friedrich and Knipping. The same year W. L. Bragg suggested a new interpretation of the diffraction maxima. He showed that the maxima in the diffraction pattern produced by a three dimentional array of atoms can be considered to be reflections from particular sets of parallel planes passing through the atoms. W. H. Bragg investigated experimentally the directions and rela-

tive intensities of reflection of x-rays from different atomic planes of rock salt and sylvine and the results were interpreted with such an ingenuity that both the wave length of x-rays and lattice constants of the crystals used were determined accurately. This sequence of discoveries was thus responsible for the development of two very important and fruitful branches of physics, *viz.*, (1) x-ray Analysis of Crystal Structure and (2) x-ray spectroscopy.

It is beyond the scope of this short article to review even briefly the achievements made by scientists in these two lines of research during the last thirty three years, but a brief mention of the nature of the results obtained will not be out of place. The methods of x-ray analysis of crystal structure have been developed so satisfactorily that the lattice constants and space groups of most of the organic and inorganic crystals and the positions of atom in the unit cells in many of them have been determined accurately. These results are of immense use in understanding many other properties of the crystals and the structure of the molecules. The methods of x-rays analysis have also been employed profitably in some industries. The results of x-ray analysis of natural fibres, such as wool, silk and cotton have been responsible for vast improvements in the quality of the yarns produced and in the methods of their production. Results of x-ray analysis of high polymers under different physical conditions and of cellulose subjected to different chemical treatments have led to tremendous improvements in the rayon industry. The plastic industry has also been benefited by such investigations. Very recently, new methods have been developed for the accurate determination of the size of the crystallites in fibres from their x-ray diffraction patterns and the correlation between the size of the crystallites and physical properties of the fibre is being gradually understood. In metal wire and sheet industry also, similar investigations have led to vast improvements.

Besides the structure of crystals, x-ray analysis has also revealed the structure of liquids and of molecules in the gaseous state. The results obtained with liquids have led to the formation of new theories of liquid structure which can explain the properties exhibited by different liquids. The interatomic distances in many polyatomic molecules in the gaseous state have been determined accurately from the x-ray diffraction patterns yielded by them.

To the physicist, however, x-ray spectroscopy has become a more fruitful line of research than the one mentioned above. Moseley first showed the relation between the atomic number of elements and the frequencies of characteristic x-rays of particular series emitted by them. Unfortunately, the first World War took away this pioneer English physicist prematurely from this world and his work was followed by physicists of other countries, the most prominent among them being Siegbahn working at Upsala. The wavelength of the lines of different series emitted by different elements have been measured accurately and the analysis of the results have revealed the existence of discrete quantised energy levels and sublevels produced by the interaction of spin of the inner electrons and their orbital angular momenta. It has been possible to measure the energies of the atoms at these different levels very accurately and the results have led to the verification of the quantum theory of the atom. The discovery of the Compton effect, which was made possible only by the development of x-ray spectroscopy, also furnishes a striking evidence for the quantum nature of the photon. This phenomenon provides the unique example in which the flow of photon-energy in bundles along definite directions is beautifully demonstrated by the conservation of the momenta of the incident and scattered photons and of the recoil electron. Probably the discovery of this diminution in the size of the photon caused by its interaction with the electrons in the matter led to the search for a similar phenomenon in the optical region, and the Raman effect, in which the photon is either diminished or increased in size during the process of scattering, was discovered by Raman in 1928.

As regards the technique for producing x-rays for different purposes, vast improvements have been made in it since the ordinary electron tube in glass bulb was designed by Coolidge. For the purpose of medical radiography shockproof oil-immersed tubes are available in the market now, complete with such control units as enables the radiologist to get the radiograph only by pressing a button. Such x-ray plants can be seen in large numbers in large cities of every country and fortunately, India does not lag behind other countries in utilising such plants for medical diagnosis and surgery. For radiotherapy 200 k.v. plants in which the x-ray tube is cooled by being completely immersed in oil which is circulated by mechanical pump are available, and these are widely used in many x-ray clinics and hospitals of large cities. There are a few such plants in India also.

Penetrating x-radiation has also been used in industrial radiography. For this purpose 400 k.v. plants with the transformer and x-ray tube immersed in oil circulated by mechanical pump together with control units for the automatic control of the exposure are sold by a few manufacturing firms. Such plants are used for testing local defects inside metallic castings or rolled sections. Since higher voltages are more suitable for examining thick sections, attempts have been made to produce high voltage plants. Million-volt x-ray plants have thus been constructed, the source of high voltage being obtained by two distinctly different types of apparatus, one of them being the high frequency transformer. The most recent in-

vention in this direction is the 'Betatron' in which 30 million volt x-rays can be produced, but such a radiation has been used only for transmutation of elements and not for any radiographical purpose. India, however, lags behind other countries in the utilisation of x-rays for industrial purpose and there is not even a single laboratory in India in which a 400 k.v. plant is being used for taking radiographs of metals. It is hoped that the Institute of Metallurgy which is going to be established very soon at Tatanagar will possess an well equipped radiological laboratory.

The technique for x-ray analysis of crystal structure has also been improved very recently. Ordinary demountable Shearer and Hadding tubes were generally used formerly in most of the laboratories. Demountable electron tubes with fixed anticathodes are now available in the market, with which a power much higher than that employed in the two types of tubes mentioned above can be obtained. This type of tube has further been improved considerably by making the target either rotating or oscillating. With such tubes currents of the order of 1 amp. at 35 k.v. can be obtained and the exposure required for photographing a diffraction pattern employing such a tube is only about one twentieth of that used in the case of a ½ K.W. Hadding tube.

Thus the discovery of x-rays has been responsible for the amelioration of human suffering, for vast improvements in many industries and for the advancement of our knowledge in atomic physics. The x-rays produced in the "Betatron" may also lead to the advancement of our knowledge in nuclear physics. There are very few discoveries in physics which have so many practical applications and have led to so many further new fundamental discoveries as this discovery of "invisible radiation" by Wilhelm Konard Röntgen.

JUBILEE OF SIR J. C. BOSE'S INVESTIGATIONS WITH CENTIMETER RADIO WAVES

D. M. BOSE

BOSE INSTITUTE, CALCUTTA

IN view of the accounts which have appeared in many journals of the rapid technical development during the war of Radar or Radio location method used for the location of objects in space by means of radio waves, it will be of interest to readers of SCIENCE AND CULTURE to learn some thing of the pioneer investigations of Sir J. C. Bose with short radio waves. It is just over half a century ago, in May 1895, that Bose communicated to the Asiatic Society of Bengal his first paper on the subject entitled 'On the Polarization of Electric Rays by double refracting Crystals'. In this paper Bose describes the apparatus used by him to obtain electromagnetic radiation of wavelength of the order of 5 mm. The interest of these investigations at the present time is that radiations of the same order of wavelengths are being used for radar detection, as a result of what Sir Robert Watson-Watt describes as the Centrimetric Revolution (*Nature, 156,* 319, 1945). 'The greatest revolution of all, however, was the campaign for centrimetric wavelengths. It had been made clear that the major defects of air borne radars, and many of the defects of the ground borne radars were curable only by the use of an extremely fine pencil of radiation. Such a pencil could only be formed by an antenna and reflector system having an aperture of many wavelengths by the use of wavelengths less than 10 cm.' The present method of generation of extremely powerful radiation of such short wavelengths was made possible by the application of the resonator cavity technique to the relatively ineffective magnetron of the previous days.

Bose's aim in these investigations was to show that electric waves possessed all the characteristic optical properties of light waves, and it was necessary for this purpose to use as small a wavelength as possible. The usual large wavelength radiations used by Hertz and Lodge required optical apparatus of very large dimensions, which gave rise to uncontrollable stray radiations by diffraction effects. Bose's apparatus eliminated all stray radiation and a narrow pencil of beam was obtained which could be made divergent or parallel by means of focussing arrangements. Bose's small and compact apparatus at once attracted the appreciative attention of many leading physicists of Europe and its description appeared in a text book by Poincare, in an Encyclopaedia Brittanica article by J. J. Thomson, and in several other text books. We give below Bose's own description of his apparatus which is contained in a Friday Evening Discourse given by him in the Royal Institution in January 1897.

"For the production of oscillatory discharge, Hertz used plates or rods with sparking balls at the ends. He found that the sparks ceased to be oscillatory as soon as the surface of the sparking balls became roughened ; there was then a leak of electricity, and no sudden discharge. The balls had to be taken out every now and then for repolishing, and the process was tedious in the extreme. Prof. Lodge made the important discovery that if two side balls were made to spark into an interposed third ball, the oscillatory nature of the discharge was not affected to so great an extent by a change in the nature of the surface. But even here the disintegration of the sparking surface produced by a torrent of sparks soon puts an end to oscillation. I found this difficulty removed by making the balls of platinum, which resists the disintegrating action. I also found that it was not at all necessary to have a series of useless sparks, which ultimately spoils the efficiency of the radiator and makes its action uncertain. A flash of radiation for an experiment is obtained from a single spark, and for a series of experiments one does not require more than fifty or a hundred sparks, which do not in any way affect the radiator. As an electric generator I use a small and modified form of Ruhmkorff's coil, actuated by a single storage cell. A spark is produced by a short contact and subsequent break of a tapping key. With these modifications one of the most troublesome sources of uncertainty is removed. The coil and the cell are enclosed in a small double-walled metallic box, with a tube for the passage of the electric beam. The magnetic variation due to the make and break of the primary of the Ruhmkorff's coil, disturbs the receiver. This difficulty is removed by making the inner box of soft iron which acts as a magnetic screen.



Sir Jagadish Chandra Bose photographed in 1897 with his short electric wave apparatus. A. radiator; B. spectrometer table; C. ebonite prism; D. receiver; E. galvanometer and cell; F. lamp with scale; G. crystal holder; other accessories lying on table.

A few words may here be said about the necessary conditions to be kept in view in making an electric wave apparatus an instrument of precision. If one merely wishes to produce response in a receiver at a distance, the more energetic the vibration is, the more likely it is to overcome obstacles. The waves may with advantage be of large size, as they

possess very great penetrative power. The surface or the depth of the sensitive layer in the receiver may be extended, for if one part of it does not respond another part will. But for electro-optical investigations the conditions to be fulfilled are quite different. Too great an intensity of radiation makes it almost impossible to prevent the disturbance due to stray radiation. As the waves are invisible, it is difficult to know through what unguarded points they are escaping. They may be reflected by the walls of the room or even by the person of the experimenter, and falling on the receiver disturb it.

The radiation falling on any portion of the receiving circuit, the leading wires or the galvanometer, disturbs the sensitive receiver. It is extremely difficult to shield the receiving circuit from the disturbing action of stray radiation. All difficulties were, however, successfully removed by the use of short electric waves. With these, it is not at all necessary to take special precautions to shield either the galvanometer or the leading wires, the sensitive layer in the receiver alone being affected by the radiation. The bare leading wires may be exposed in close proximity to the source of radiation, and yet no disturbance is produced.

For experimental investigations it is also necessary to have a narrow pencil of electric radiation, and this is very difficult to obtain, unless waves of very short length are used. With large waves diverging in all directions and curling round corners, all attempt at accurate work is futile. For angular measurements it is necessary to direct the electric beam in the given direction along narrow tubes, and receive it in another tube in which is placed the receiver. The waves experience great difficulty in passing through narrow apertures, and there are other troubles arising from the interference of direct and reflected waves. All these drawbacks were ultimately removed by making suitable radiators emitting very short waves ; the three radiators here exhibited, give rise to waves which are approximately ¼ inch, ½ inch and 1 inch in length. The intensity of emitted radiation is moderately strong, and this is an advantage in many cases. It sometimes becomes necessary to have a greater intensity without the attendant trouble inseparable from too long waves. I have been able to secure this by making a radiator, where the oscillatory discharge takes place between two hollow hemispheres and an interposed platinum ball. The intensity of radiation is by this expedient very greatly increased. The parallel pencil of electric radiation, used in many of the experiments to be described below, is only about one cm. in diameter. The production of such a narrow pencil became absolutely necessary for a certain class of investigations. Merely qualitative results for reflection or refraction may no doubt be obtained with gigantic mirrors or prisms, but when we come to study the phenomena of polarization as exhibited by crystals, Nature imposes a limit, and this limitation of the size of the crystals has to be accepted in conducting any investigation on their polarizing properties.

The greatest drawback, however, in conducting experimental investigations on the optical properties of electric radiation arises from the difficulty of constructing a satisfactory receiver for detecting the radiation. For this purpose I at first used the original form of coherer made of metallic filings as devised by Professor Lodge. It is a very sensitive detector for electric radiation, but unfortunately its indications are often extremely capricious.

The conditions for a satisfactory receiver are the following :—

(1) Its indications should always be reliable.
(2) Its sensitivenes should remain fairly uniform during the course of the experiment.
(3) The sensibility should be capable of variation, to suit different experiments.
(4) The receiver should be of small size, and preferably linear, for accurate angular measurements.

These conditions seemed at first almost impossible to attain ; the coherer sometimes would be so abnormally sensitive that it would react without any apparent cause. At other times, when acting in an admirable manner, the sensitiveness would suddenly disappear at the most tantalising moment. It was a dreary experience when the radiator and the receiver failed by turns, and it was impossible to find out which was really at fault.

From a series of experiments carried out to find the causes of the erratic behaviour of the receiver, I was led to suppose that the uncertainty in its response is probably due to the following :—

(1) Some of the particles of the coherer might be in too loose a contact against each other, whereas others might be jammed together, preventing proper response.
(2) The loss of sensibility might also be due to the fatigue produced on the contact surfaces by the prolonged action of radiation.
(3) Since the radiation was almost entirely absorbed by the outermost layer, the inner mass, which acted as a short circuit, was not merely useless but might introduce complications.

For these reasons I modified the receiver into a spiral-spring form. Fine metallic wires (generally steel, occasionally others, or a combination of different metals) were wound in narrow spirals and laid in a single layer on a groove cut in ebonite, so that the spirals could roll on a smooth surface. The spirals

are prevented from falling by a glass slide in front. The ridges of the contiguous spirals made numerous and well-defined contacts, about one thousand in number. The useless conducting mass was thus abolished, and the resistance of the receiving circuit almost entirely concentrated at the sensitive contact surface exposed to radiation. If any change of resistance, however slight, took place at the sensitive layers, the galvanometer in circuit would show strong indications. The pressure throughout the mass was made uniform as each spring transmitted the pressure to the next. When the contact surfaces had too long been acted on, fresh surfaces could easily be brought into operation by the simultaneous rolling of all the spirals.

The sensibility of the receiver to the radiation, I found, depends (1) on the pressure to which the spirals are subjected, and (2) on the E.M.F. acting on the circuit. The pressure on the spirals may be adjusted, as will be described later on, by means of a fine screw. The E.M.F. is varied by a potentiometer-slide arrangement. This is a matter of great importance, as I often found a receiver, otherwise in good condition, failing to respond when the E.M.F. varied slightly from the proper value. The receiver, when subjected to long-continued radiation undergoes exhaustion. The sensibility can, however, be maintained fairly uniform by slightly varying the E.M.F. to keep pace with the fatigue produced.

The receiving circuit thus consists of a spiral-spring coherer, in series with a voltaic cell and a dead-beat galvanometer. The spirals are placed between two pieces of brass, of which the upper one is sliding and the lower one fixed. These two pieces are in connection with two projecting metallic rods, which serve as electrodes. An electric current enters along the breadth of the top spiral and leaves by the lowest spiral, having to traverse the intermediate spirals along the numerous points of contact. When electric radiation is absorbed by the sensitive surface, there is a sudden diminution of the resistance, and the galvanometer spot is violently deflected.

By means of a very fine screw the upper sliding piece can be gently adjusted in or out. The spirals can thus be very gradually compressed, and the resistance of the receiver diminished. The galvanometer spot can thus easily be brought to any convenient position on the scale. When electric radiation falls on the sensitive surface the spot is suddenly deflected.

The receiver thus constructed is perfectly reliable ; the sensibility can be widely varied to suit different experiments, and this sensibility can be maintained fairly uniform. The sensitiveness, when necessary can be exalted to almost any extent, and it is thus possible to carry out some of the most delicate experiments (specially on polarisation) with certainty. In my more recent apparatus I use a single-contact receiver made of steel, nickel, aluminium or magnesium. These receivers can not only be made extremely sensitive, but also highly reliable.

The main difficulties having been thus removed, I attempted to construct a portable apparatus, with which all the experiments on electric radiation could be carried out with almost as great an ease and certainty as corresponding experiments on light, and with which even quantitative results could be obtained with fair accuracy.

The complete apparatus is here exhibited ; all its different parts, including the galvanometer, and all the accessories for reflection, refraction, polarisation, and other experiments are contained in a small case only 60 cm. in length, 30 cm. in height and 30 cm. in breadth. The apparatus can be set up and various adjustments made in the course of a few minutes.

The radiating apparatus is $15 \times 12 \times 7$ cm., the size of a small lantern. It contains the coil and a small storage cell ; the radiator tube is closed with a thin plate of ebonite to prevent deposit of dust on the radiator. One charge of the cell stores enough energy for numerous experiments. It is always ready for use and requires very little attention. A flash of radiation for an experiment is produced by a single tap and break of the interrupting key.

The radiating apparatus and the receiver are mounted on stands sliding on an optical bench. Experiments are carried out with divergent or parallel beams of electric radiation. To obtain a parallel beam, a lens of sulphur or glass is mounted in a tube. Suitable lenses can be constructed from the accurate determination, which I have been able to make, of the indices of refraction of various substances for the electric ray, by a method which will be described later on. This lens-tube fits on the radiator-tube, and is stopped by a guide when the oscillatory spark is at the principal focus of the lens. The radiator-tube is further provided with a series of diaphragms by which the amount of radiation can be caried.

For experiments requiring angular measurement, a spectrometer-circle is mounted on one of the sliding stands. The spectrometer carries a circular platform, of which the various reflectors and refractors are placed. The platform carries an index, and can rotate independently of the circle on which it is mounted. The receiver is carried on a radial arm (provided with an index), and points to the centre of the circle."

With the help of this apparatus Bose carried on investigations on absorption of the radio waves in different substances, the verification with them of the laws of reflection, determination of the refractive

indices of several dielectric substances transparent to these radiations, double refraction and polarisation in crystals, strain double refraction, anomalous conductivity associated with certain types of polarisers, rotation of plane of polarisation by a bundle of twisted jute fibres etc., Bose further carried out investigations on the possibility of using such radiation for signalling through space. He used upright rods with metal plates as antennas for the sending and receiving of signals. The possible commercial applications of his discoveries attracted the attention of certain British firms. Bose was, however, more interested in pure research, and in founding a school of research in his own country, and the question of practical utilization of his discoveries did not attract him. Bose's apparatus perfect in its own way, however, cannot be expected to rival the performance of modern short wave senders used for radio location and television. But his discoveries could have been made the starting point of many promising applications in this country had a suitable environment for the utilization of such discoveries existed then. There was not and even now probably there is not that wide awakenedness in our country on the necessity of developing and utilizing for practical purposes new discoveries made by our own countrymen in this country. Bose's investigations with micro-waves did not lead to any effort for development of radio communication. His investigations on photo conductivity and contact rectification in semiconductors like selenium, which have found important technical applications in Europe and America have not been followed up here. Recent reports from Russia indicate that photo-electric current per unit light intensity obtained from a tantalum sulphide-iron combination is twenty-five times greater than that given by selenium iron combination. Such photo cells have now become sufficiently efficient to make it practicable to set up large batteries of them in desert places for the conversion of solar energy into electrical energy. No attempt has yet been made to develop Bose's exceedingly sensitive magnetic Radiometer into a precision apparatus for radiometric measurements. We have to confess that in the Bose Institute we have concerned ourselves only with the extension of the founder's plant physiological investigations, and we have not explored the practical application of his physical discoveries and inventions. Limitation of our own resources, war-time shortage of necessary materials and the difficulty of getting suitably trained men, who are attracted by better terms elsewhere, have restricted our activities in this direction.

ANTIBACTERIAL SUBSTANCES FROM MOULDS

P. NANDI

DEPARTMENT OF MICROBIOLOGY, BOSE RESEARCH INSTITUTE, CALCUTTA

INTRODUCTION

IT is well-known that in mixed cultures of micro-organisms, a particular species by its presence may suppress completely or partially the growth of other species. This phenomenon which has recently attracted the special attention of microbiologists and chemists has been explained on the assumption that in most cases the metabolic product of one, while relatively harmless to itself, may become harmful or extremely toxic to a different species. If there are two micro-organisms A and B, of which A suppresses the growth of B, and if B is pathogenic to man while A is non-pathogenic, there arises the possibility of isolating a new chemotherapeutic agent from the metabolic filtrate of the non-pathogenic organism A. The recently discovered Penicillin belongs to this type of mould product.

In recent years the antibacterial substance produced by several species of *Penicillium* and specially by *P. Notatum* has attracted a great deal of attention, chiefly amongst medical men, due to the fact that it has several advantages over the established synthetic compounds of the sulphonamide group as being less toxic or non-toxic to the human system. Antibacterial agents available upto a few years ago belonged usually to a class of protoplasmic poisons and their activity was explained in terms of their ability to denature proteins of the microbial cells or to produce oxidation of the protoplasmic constituents. The mode of action of the sulphonamides has been investigated and it has been established that these drugs are primarily bacteriostatic and not bactericidal. They interfere with the nutrition of the susceptible bacteria either by combining with the substratum of the organism or by their action upon the cells which prevent them from utilizing the available nutrition. The mould antibacterial products like Penicillin appear to react in a similar manner. The present report deals with the determination of the optinium conditions necessary for the production

of an antibacterial substance from a related strain of *Penicillium Citrinum Thom.*

Experimental

Culture :—The culture of Penicillium used for this investigation was isolated from the local garden soil of which a stock of pure culture is being maintained. This species of Penicillium is closely related to P. citrinum in most of its characteristics. The biochemical reactions specially the characteristic ferric chloride reaction with the metabolism solution are identical with the observations of the previous workers on this strain. The metabolic filtrate of the fungus is coloured yellow-orange in a modified Czapek-Dox medium.

Media :—The growth of the fungus has been observed on several synthetic media with suitable modifications in most cases. Standard Cz-Dox composition has been taken as the basal nutritive medium. The modifications were made with the addition of, (*a*) extracts of fruits and other vegetables, (*b*) organic acid salts (citrates, tartrates and acetates). Equivalent substitutes of the constituents of the basal media are also used. Nitrates are substituted by amino acids and glucose by disaccharides and monosaccharides.

Technique for Routine Experiments

For all routine experiments 50 c.c. of the liquid media were placed in 250 c.c. Erlenmeyer flasks, (depth of the liquid being less than 2 c.m.) plugged with cotton wool and sterilized at 10 lbs. pressure for 20 minutes except in the case of media containing potato extract. Each batch is sown with a suspension of spores from freshly-grown fungus in wort-agar slants. The flasks were incubated in a room having controlled temperature condition at 22°C. The changes occurring in the media during the growth of the fungus were analyzed daily commencing from the second day of incubation and different tests were made with a view to trace the appearance and growth of the antibacterial substance in the substratum. The results are summarized in table I and are represented by curves in figs. 1 & 2 ; (1) changes of *p*H, (2) residual glucose, (3) absorption of bromine, (4) reaction with $KMnO_4$ soln, (5) reaction with $FeCl_3$ soln. and (6) test of antibacterial potency.

*Change of p*H :—The figures for change of *p*H in the table are represented in the graph showing that there is an initial fall of *p*H starting with 6·4. The value decreases upto a minimum of 3·4 and remains constant for 2—4 consecutive days, followed by a steady rise with a final attainment of the highest value of 7·5. It appears from the curves that a distinct acidic reaction of the substratum is favourable for the production of the antibacterial substances.

TABLE I

Days	*p*H	% Residual Sugar	Bromine absorption per c.c.	$KMnO_4$ reaction per c.c.	$FeCl_3$ Reaction	Bacteriostatic Action Dilutions					
						1/5	1/10	1/20	1/30	1/40	1/50
0	6·4	—	—	—	—	—	—	—	—	—	—
1	6·4	—	—	—	—	—	—	—	—	—	—
2	5·4	3·8	—	—	—	—	—	—	—	—	—
3	3·8	2·0	0·03	0·09	+	+	+			—	—
4	3·8	1·0	0·15	0·15	+ +	+	+	+	+	—	—
5	3·8	0·5	0·27	0·15	+ + +	+	+	+	+	+	—
6	3·4	0·2	0·27	0·24	+ + +	+	+	+	+	+	
7	3·4	0·12	·2	0·06	+ + +	+	+	+	—	—	
8	3·8	0·12	11	0·06	+ + +	+	+	—	—	—	
9	3·8	0·12	·06	0·03	+ + +	+	—	—	—		
10	4·6	0·1	·06	0·03	+ +	+	—	—	—	—	
11	5·2	0·1	·04	0·03	+	—	—	—	—	—	
12	6·0	0·1	·03	0·03	+	—	—	—	—	—	

Residual Sugar :—The utilization of glucose is represented by figures of residual sugar estimated by Benedict's quantitative method. The rate of consumption is slow uptil the first 48 hours of incubation and a marked increase in the rate is observed during the later 48 hours, when the formation of spores becomes complete and the production of antibacterial substance begins. At this stage the sugar content comes down to 1% or less and the remaining quantity of sugar is consumed very slowly. The highest titre of activity of the metabolic filtrate is attained after 96 hours of incubation and remains constant for at least 48 hours followed by a rapid reduction. The complete disappearance of the sugar may result in the destruction of the antibacterial substance excreted into the medium.

Bromine Absorption :—Saturated aqueous solution of bromine is carefully added from a finely graduated 10 c.c. burrette to 1 c.c. of the test solution. The figures in the table indicate the required amount in

each case. It appears that there is a fall in the rate of absorption of bromine with the age of the culture and it is proportional to the reduction of antibacterial titre.

Reaction of $KMnO_4$ Solution:—The metabolism solution of 1 c.c. quantity is titrated with N/5 $KMnO_4$ solution. The figures in the table indicate the amount of $KMnO_4$ solution required for 1 c.c. of the test solution. The reaction of the medium becomes alkaline during the latter period of growth of the fungus when the titre value of $KMnO_4$ also diminishes, and the production of antibacterial substance is proportional to the intensity of $KMnO_4$ reaction.

sterile conditions. Dilution of the filtered solution from 1:5 to 1:50 were made in 5 ml. quantities of glucose-broth (*p*H 7·2). Each tube is seeded with a loopful of 24 hour culture of staphylococcus aureus and incubated at 37°C for 48 hours. The result recorded are given in the table. Complete inhibition of bacterial growth was found at dilutions upto 1:30 and partial upto 1:40. The turbidity of the broth media indicates failure of inhibition as clearness indicates complete inhibition of bacterial growth. The unit of bacteriostatic activity chosen here is in accordance with Waksman's suggestion. (One unit activity with reference to the test organism = 10/ amount of culture filtrate necessary to inhibit growth

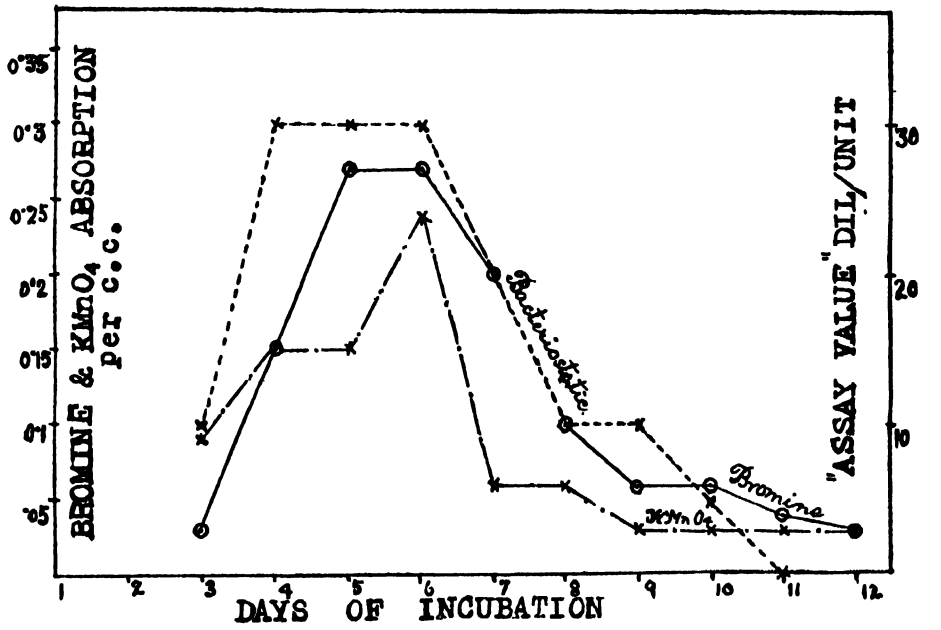


Fig. 1

Reaction with $FeCl_3$ Sol.:—Ferric chloride, at first, gives a deep iodine-brown precipitate with the filtered metabolism solution and on addition of excess of the reagent the precipitate dissolves. The colour reaction has a wide range varying with the length of incubation period. The antibacterial property of the metabolism solution of a particular batch will be negligible, if in case, the ferric chloride reaction is negative.

Assay of Anti-bacterial Potency:—The antibacterial powers of the culture-filtrates were determined according to serial dilution method. A glucose-broth medium containing the following substances, *viz.*, Peptone 1%, NaCl 0·5%, Beef ext. (Difco) 0·3% and glucose 2·0%, (*p*H 7·2) was selected.

The metabolism solution is passed through Seitz Filter and preserved in well-stoppered bottles under

of the test organism in 10 ml. of nutrient broth). Several strains of *P. notatum* Westling were grown and the activity of their culture filtrate was tested. The results varied between a minimum of 10 to a maximum of 500 units of activity. The cause of this wide variation is due to the specificity of strains in producing antibiotic substances.

Discussion

In the present investigation, an attempt has been made to study the changes occurring in the composition of the media during the incubation period of the organism. The selected basal media is modified Czapek-Dox solution. The variation in the composition of the medium is made with the basal nutrient solution as standard.

A change is set up in the medium at the initial stage and the reaction proceeds from alkaline to acidic, which favours both vigorous growth of the organism and production of anti-bacterial substance. In the later phase of growth a reversion towards alkalinity in the metabolism solution takes place; this is supposed to be one of the causative factors for the rapid inactivation of the active substance.

potassium permanganate and ferric chloride probably indicate the presence of a single or a group of organic compounds synthesized during the metabolic process of the organism. The intensity of these reactions in the routine samples of the metabolism solution is proportional to the activity of the anti-bacterial substance thus produced.*

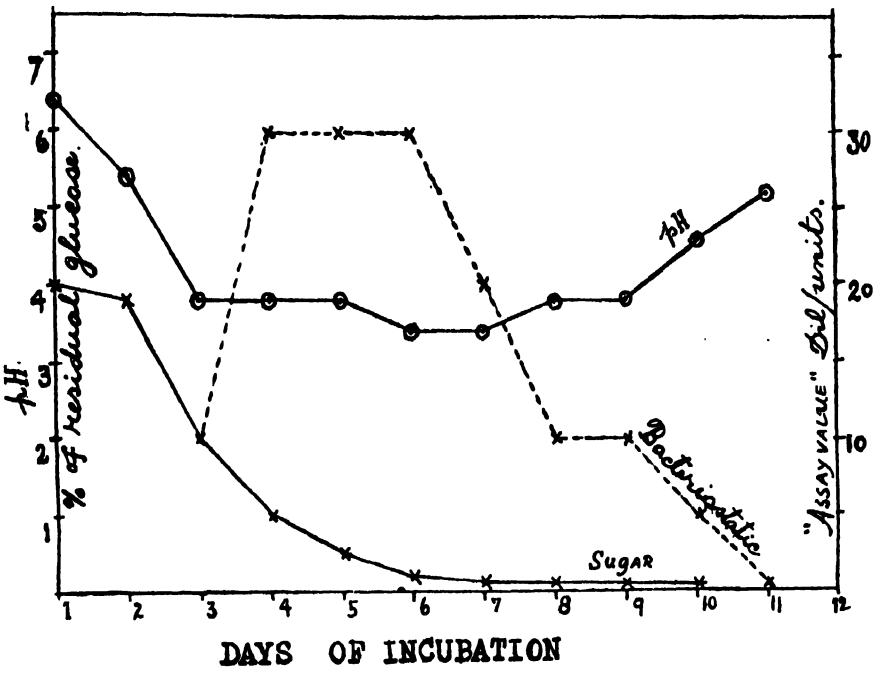


Fig. 2

Glucose, the simplest source of carbohydrate, is used and its absorption is effected without being interfered with by the complexity of intermediate reactions. The maximum growth of the organism is attained by the utilization of the major portion of the sugar in the medium. The formation of the anti-bacterial substance is probably not as a result of autolysis of the fungus, since the activity of the filtrate was rapidly reduced at the later period of incubation. Still, it remains to be determined whether the active substance is produced during the break-down of carbohydrates or synthesized in the cell-substance, and excreted afterwards into the substratum.

The absorption of bromine and reactions of

REFERENCES:

Clutterbuck, Oxford, Raistrick *et al, Biochem. Jour., 26,* 1441, 1932.
Raistrick *et al. Phil. Trans. Roy. Soc.* (*Series B*), *220,* 1931.
Raistrick and Smith, *Chem. Ind. 60,* 41, 1941.
Clayton, Robinson *et al. Biochem Jour., 38,* 355, 1944.
Brownlee *et al., Biochem. Jour., 37,* 5, 572, 1943.
Tatum, *Ann. Rev. Biochem.,* 1944.
Waksman *et al. Proc. Nat. Aca. Sc.* (U. S. A.), *30,* 5, 1944.
Waksman *et al. Mycologia, 35,* 1943.

* I desire to express my sincere gratitude to Dr D. M. Bose, the Director of the Bose Research Institute, Calcutta for originally suggesting this problem and for his continued interest in it throughout the investigation. The authorities of Messrs. Bengal Immunity Co., Ltd., Calcutta are to be thanked for sanctioning a research grant to this purpose for one year. Finally, I would like to offer my best thanks to my colleague Dr H. K. Baruah for his help and valuable suggestions.

UTILIZATION OF NUCLEAR FISSION ENERGY

IN our last issue (November 1945) we reproduced the contents of a pamphlet published by the British Government, entitled "Statements Relating to the Atomic Bomb". It contained an account of the investigations carried out in the United Kingdom culminating in the production of Atomic Bombs in the U. S. A., after a pooling of the scientific and technical efforts in the U. K., Canada and the U. S. A. The British narrative stops with the decision taken by the allies towards the end of 1943 to transfer the whole investigation to Canada and the U. S. A.

A corresponding statement on the American part of the investigation has been prepared by Dr H. Smyth entitled "A General Account of the Development of Methods of Using Atomic Power for Military Purposes Under the Auspices of the United States Government 1940-45". The *Review of Modern Physics* has announced its publication in its October issue, but in the mean time a brief account taken from the above document has appeared in the September issue of the *Review of Scientific Instruments*, which is intended to clarify the rather turgid popular accounts which have recently appeared describing research on atomic bomb. This account is reproduced here ; it gives an idea of the tremendous amount of energy released during the nuclear processes involved in the production of Plutonium from Uranium 238. The former element is being used to replace to a large extent U^{235} in the making of atomic bombs. For future industrial applications the heat dissipated during the production of Plutonium and its subsequent fission will most probably be utilized. At the same time the dangers involved in the course of manufacture of this new element is stressed in the account.

"All physicists knew in 1940 that there was a strong likelihood that a self-sustaining nuclear reaction could be set up in a sufficiently large mass of material which would undergo fission if bombarded with slow neutrons, especially if the mass contained material of low atomic weight and small neutron capture cross section, present for the purpose of slowing down to thermal velocities the neutrons resulting from fission. The theoretical possibility of realizing such a self-sustaining fission 'pile' (as it has come to be known) could not be stated without more exact determinations than had then been made of various cross-sections for neutron capture in uranium and other materials. The experimental test of the possibility required quantities of uranium which were not available in 1940. Such a 'pile' could in principle be controlled by inserting into it neutron-absorbing material ; it would be prevented from running away by the fact that a small but substantial fraction of the total number of neutrons emitted as a result of fission were delayed by times up to one minute after the fission itself had occurred.

Such a 'pile' would evidently have possibilities as a power source, but it would not be much good as a bomb, for the time necessary to slow down fission-produced neutrons to the thermal velocities at which they could themselves produce other fissions, though small, was considerable. It was discovered in 1940, however, that U^{235} undergoes fission when bombarded with fast neutrons ; a self-sustaining chain reaction involving U^{235} could presumably proceed with great explosive violence. This was very roughly the situation when security began to be imposed on work in the field of nuclear fission.

The administrative history of the nuclear projects is complicated and interesting ; it is traced by Smyth but will not be reproduced here. Early efforts were devoted to establishing whether a chain reaction could be realized or was impossible, and to various explorations of the possibility of separating U^{235} in bulk from natural uranium, in which it occurs to the extent of one part in 140. Large scale plants for the separation of U^{235} were built in Tennessee ; one was a gaseous diffusion plant with a great number of stages, and the other was a mass-spectrograph type of separator operating at high beam currents. The latter plant, whose first units were put into operation by the end of 1943, was later aided by a thermal-diffusion plant built to enrich the feed material. The great gaseous-diffusion separation plant was put into operation 'before the summer of 1945', according to Smyth. Presumably enough U^{235} has been separated to permit its use in bombs ; the interesting story told by the Smyth report is nevertheless that of the self-sustaining fission 'pile', and of the atomic explosive resulting from its use.

This story is interesting because it is told in greater detail. It is also interesting because practical atomic power plants will—when they are practical—derive from the 'pile' as it is now known. And the superlatives which can be applied to the whole investigation beggar comparison.

While there was quite natural interest from 1940 on in the possibility of constructing such a pile, and work was done at Columbia, Chicago, and Princeton to investigate its possibility, Dr E. O. Lawrence made a suggestion in May, 1941 which led to a redoubling of efforts in this work. His co-workers at the Radiation Laboratory in Berkeley had found, in experiments begun the preceding summer, that capture of a neutron by U^{238} was followed by two successive beta-ray disintegrations of the resulting U^{239} nucleus

(half-lives 23 minutes and 2·3 days). The final atomic species, of atomic number 94 and atomic weight 239, was a relatively stable alpha-emitter of long-half-life. This new chemical element has been named plutonium (symbol Pu) ; the intervening element of atomic number 93 has been named neptunium (Np). Pu^{239} was found to undergo fission when bombarded with fast neutrons. It was therefore, like U^{235}, a substance suitable for use in an atomic bomb. Lawrence mentioned this and suggested the large scale operation of piles specifically for the purpose of making plutonium in bulk ; he pointed out that this would result in making use of U^{238}, which constitutes most of natural uranium, for atomic energy production. Plutonium, different chemically from uranium, could be separated by relatively simple processes from uranium which had been bombarded by neutrons in a pile ; the difficulties of isotope separation were thus avoided.

It was learned in the course of early experiments that a pile so nearly (made?) would not work, that great attention had to be paid to the purity of materials of which it is built. In particular, the 'moderator' (as the substance used to slow down the fission neutrons is called) must not itself absorb neutrons appreciably, must have a relatively low atomic weight, and must not contain neutron-absorbing impurities. Carbon in the form of graphite has been mainly used as a moderator in practical piles. Uranium metal had been prepared in small amounts for special purposes before the war ; now it was not only needed by the ton, but had to be of unexampled purity. By November 1942, six tons of uranium metal were available, and the first self-sustaining pile was built at the University of Chicago, with graphite as a moderator. This first ran on December 2, at a power —produced by nuclear fission of about ½ watt. On December 12, the power was allowed to increase to 200 watts. The power level at which the pile operated was controlled by inserting strips of cadmium or of boron steel into slots in the structure.

Success in operating this pile brought an immediate decision to construct large units for the production of plutonium. An yield of one kilogram per day of plutonium would require the operation of a pile at a power of 500,000 to 1,500,000 kilowatts. Despite the immense extrapolation that was involved, high power piles were planned, and construction of the first of three such piles began on the site at Hanford, Washington on June 7, 1943. This first great pile was put into operation in September 1944, and all three piles were working by the summer of 1945. Shields, handling equipment, separation plants, and other equipment needed are all on the site at Hanford.

Meanwhile, a pile of intermediate size was planned for the Clinton site in Tennessee. It was to be an air-cooled pile developing 1000 kilowatts. It was intended at first as a pilot plant for the Hanford piles, which were originally planned for helium cooling, but the decision to water-cool these latter piles was later made. The Clinton pile began operation on November 4, 1943, and was soon up to 500 kilowatts. The first batch of uranium slugs from the pile went to the separating plant on December 20, 1943 ; and by the end of January, 1944, ½ of a ton of metal per day was coming out of the pile. 190 milligrams of Pu had been separated by February 1, 1944 ; and several grams by March 1. By May, the power of this pile had been raised to 1800 kilowatts, and was increased still further in June.

Even though only tiny amounts of plutonium were than available, the chemistry of this new element had been well worked out by the end of 1942. Pu is very similar to uranium ; uranium can be thought of as the beginning of a sort of rare-earth family. Pu shows positive valences of 3, 4, 5, and 6. Its separation from uranium and fission products is accomplished by a precipitation process which was chosen on a knowledge of plutonium chemistry gained from experiments on less than one milligram of plutonium. This process has worked in a way exceeding all expectations in the operation of the Hanford plant.

The difficulties ancillary to the main business of the project, hinted at in Smyth's report, were prodigious but have been overcome. Health of workers had to be guarded despite the handling of tons of intensely radioactive material. Hundreds of thousands of kilowatts of power had to be dissipated. The utmost reliability was required in equipment necessary to operation of the piles, for a breakdown would have rendered the pile permanently useless because of the impossibility of repair workmen entering the shield surrounding the pile. The design of the air-tight, radiation-proof shields around the piles was an entirely new problem. Previously unknown changes in the properties of materials occur under the intense bombardment experienced by everything near or within the pile. Kilograms of intensely radioactive fission products had to be disposed of in a way which would not be dangerous to human life. The handling of uranium slugs and the plutonium separation process have to be carried on by automatic machines controlled from behind shields.

Finally, an effective and reliable bomb had to be made, either from U^{235} or from Pu^{239}. It appears from Smyth's account that both materials may have been used. The job of designing the bomb was done by a research group at Los Alamos, near Santa Fe, New Mexico. For reasons of security, Smyth's description of this work is sketchy in the extreme, but he indicates that fundamentally the bomb is made by preparing several pieces, each of sub-critical size

(too small to produce a chain reaction), which fit together to form a mass well above critical size. These are kept separate until the bomb is to be set off, when they are brought together in a very special undescribed way.

It is to be hoped that, now the war is over, the basic physics of nuclear engineering as it has been worked out during the war will be published to the greatest extent compatible with a sensible and considered view of security requirements. The enormous neutron intensities which are now available and the feasibility of producing most radioactive nuclei in ponderable amounts, to mention two specific examples, promise enormous advances in post-war nuclear physics research. Smyth's report, though it was doubtless allowed to appear partly to insure a wide appreciation of the revolutionary character of the atomic bomb, and thus enhance its psychological value as a weapon, suggests strongly that the handling of security concerning nuclear matters will be sensible and no stricter than is absolutely necessary. All physicists will applaud the wisdom of such a policy."

SOME ASPECTS OF FOOD PRESERVATION

S. S. DE,

INDIAN INSTITUTE OF SCIENCE, BANGALORE

VARIOUS committees in different countries are planning for the future. The prime requisite for a good social order is the provision of environmental conditions under which every one will enjoy his or her inherited capacity for physiological well being. Balanced food adequate for health is fundamental to well being. Man in the primitive ages used to take raw foods, but when they came to know the use of fire, they began to cook their food. Cooking early developed into an art and later, a science. As food became more abundant and more diverse, greater care was taken in its preparation partly because of the increased palatability of cooked food. To-day the purpose of cooking rightly applied, is to render food more tender, more digestable, more palatable, and also to destroy harmful micro-organisms. But very little attention is paid for the loss of minerals and vitamins in the course of cooking. Time, rate of cooking, utensil used and ratio of water to food (vegetables) are important factors in assessing the destruction of nutritive values such as vitamins and mineral elements. Before going to discuss the subject it will be useful to state the estimated average requirement of a man which is as follows:

Protein	70 gms.	Vitamin C	50-75 mgms.
Calcium	0·7 gms.	Riboflavin	2-3 mgms.
Iron	12 mgms.	Nicotinic acid	10-15 mgms.
Vitamin A	4000-5000 I.U.	Vitamin D	400 I.U.
Vitamin B_1	1·5-2·0 mgms.		

The above list seems to be not complete in itself as our present knowledge of vitamins have included vitamins like Pyridoxine, Panthothenic acid, Choline, Inosital, Biotin, *p*-aminobenzoic acid, K, Hesperidin (P), Filtrate factor (W), and Folic acid their need not being established for man. So in the near future we may have to consider these vitamins also. When one considers the food supply of the country with respect to the nutrients per head of the population, it should not be forgotten that it should be based on physiological needs. With increase of population and shortage of food one has to depend on processed foodstuff. With the advent of science we will be getting more of manufactured or processed foodstuffs for our needs. Such processings are adopted for various reasons, they may be to get the food in cooked condition or preserving it from spoilage due to storage. But whether such processes retain the nutritive value of the foodstuff should be investigated in all its aspects. As a scientist we should not only concentrate our attention to the nutritive value of the food but also look to the taste and flavour of the product as they play an important role in our digestion. Fuller investigation by manufacturers, of the influence of their processes on the nutritive value of their products, is required. Thus food technology has a great future and food manufacturers greater responsibilities than what they had in the past and they will have to play a big part in attaining a national nutritional policy of the country.

Legislation is required for food manufacturers in securing adequate nutrition. Food manufacturers should try to retain all the minerals and vitamins present in the natural food. False advertisements regarding the quality of the food should be prohibited. As for fruit product it should be stated that it has been prepared from fresh fruit and should contain a stated minimum ascorbic acid. No food should be permitted to be labelled "rich in vitamins" unless it is definitely stated. The food manufacturers should give much care and thought not only for the qualities that attract the public but also in safeguarding the nutritional value

of the product. The scientist should not only help the manufacturers in their problem but should also educate the public as to what is nutritive or not.

The main processes that have been adopted for the preservation of food are:

(1) Canning ; (2) Dehydration ; (3) Refrigeration.

Canning.—Prior to 1800 the three methods known for preserving food were: (*a*) Freezing, (*b*) dehydration, (*c*) addition of chemicals, such as salt, vinegar, sugar, smoking, fermentation etc. The name of Nicolas Appart is well connected with canning history. He was born near Paris in 1752 and had spent most of his life in kitchens, wine cellars and vineyards. He carried out a large number of experiments on preserving food products with closed bottles as containers. In 1804 he was able to submit some products to the Minister of Marine at Best for testing. He was awarded a prize of 12,000 francs for his book entitled "The art of preserving all animal and vegetable substances for many years" published in 1810. Thus was born the canning industry. In the year 1810, Peter Durand, a merchant of Middlesex patented on the use of tin containers for preserving food. But the commercial practice of canning dates from about 1820. At present we are acquainted with the general principles and outlines of it, but good deal is yet to be done to have a detailed and extensive knowledge of the subject. In canning relatively high temperatures are employed in overcoming microbial infection than in refrigeration and quick freezing, the process of deterioration being suppressed or inhibited. The processing as adopted in different industries is mostly mechanical development of home cooking with greater scientific control to produce a uniform quality. Canning gives long life to the commodities. It is generally expected that fruits will last a year, vegetables about five years and meat should keep for a longer period. The efficient preservation by canning depends not only on the quality of the tin but also on the methods of tinning them. The efficiency of the displacement of air from the cans prior to sealing is a factor of importance. Fair amount of work has been carried out as regards the loss of nutritive value in domestic cooking and in the preparation of canned products. As for vitamin A and D they stand up to canning. Vitamin C is present in satisfactory amount but preservation of vitamin B_1 is a difficult proposition. The keeping quality of the vitamins of the B_2 complex in canned food has not been systematically investigated.

Refrigeration.—From time immemorial ice and snow have been used for preserving foodstuffs, but the manufacture of artificial ice for chilling foodstuffs was developed on a commercial scale from about 1875, but many setbacks were experienced and until recently no systematic research was carried out. It was only about five years ago that the behaviour and structure of foodstuffs during chilling, freezing, during storage and effect of the atmosphere in storage began to be investigated in a systematic manner. The temperature, the air humidity and the air movement have been found to be important factors, but recent commercial practices have shown that storage atmosphere is one of the main factors controlling the long life and quality of stored foodstuffs.

Birdseye judging the importance of food preservation by refrigeration remarked that in the last thirty years, the use of mechanical refrigeration has grown so tremendously that no urban population in the United States could survive for more than thirty days or so without cold storage foods of one sort or another. New York could not live for more than ten days to two weeks without cold storage foods. In ordinary cold storage it takes from three to seventy two hours depending on their bulk. and the particular methods and facilities employed and during that time ripening of the living materials occurs and spoilage by moulds and bacteria. This has been prevented by quick freezing process which preserves the fresh colour, flavour and palatability of fruits and vegetables better than any other method of food preservation. There are a number of methods for quick freezing and they may be grouped into three classes:

(1) freezing by direct immersion in brine ;
(2) freezing by indirect contact with refrigerant ;
(3) freezing in blast of cold air.

Freezing, especially the modern method of rapid freezing, is probably the most successful procedure for preserving the nutritive quality of fresh fruits and vegetables. Meat and fish lose little of their nutritive value after storing for long periods in the frozen state. Refrigeration of foodstuff has been so perfected that sole has been kept in Tory Research Station at Aberdeen at $-30^{\circ}C$. for at least four years in such state that it could not be distinguished from fresh sole as regards its palatability and freshness. The modern tendency is to refrigerate meat, fish, butter and cream at a very low temperature ($-18^{\circ}C$.). Such a low temperature is required because of the microbiological action and oxidation of fatty tissues, which become negligent in such low temperatures. But for vegetables less intensive degree of cooling is required. The duration of safe storage of chilled foodstuffs has been extended by increasing the carbon dioxide content of surrounding air—a procedure known as gas storage. Some amount of work has been done on the conservation of vitamin C in vegetables but more detailed information is required

as to the optimum conditions for different type of vegetables.

Dehydration.—Foodstuffs such as dried fruits and dried milk have long been articles of commerce. The main advantage about dehydration is that it requires less space. The conservation of tin plate has given an impetus to the processing of food by dehydration. Dehydration is conducted in a stream of hot air until the water content of the material being dried is reduced below 5 per cent, the temperature of the air stream being raised according to the type of material. Dehydrated foodstuffs, even if the water content is reduced below that necessary for the development of bacteria, are still perishable. In order that they may be processed efficiently their surface must be great in proportion to their bulk, and this makes them susceptible to oxidation. The fats of dehydrated meat, milk and eggs slowly change and develop "off flavours". The dehydrated products can be stored for long periods only if they are sealed under an inert gas and kept at low temperature. Access of air or moisture, particularly at high temperature results in rapid loss of the nutritive properties. In the dehydrated vegetables ascorbic acid and pro-vitamin A are destroyed rapidly unless the material is sealed in oxygen-free atmosphere. Retention of colour, flavour, texture and vitamin-content during dehydration depends mainly on the destruction of oxidizing enzymes, by heat. This is accomplished by "blanching" in steam, boiling water or boiling sodium sulphite solution. The dehydrated food when reconstituted retains all the freshness of the natural product and in a recent experiment with cabbage, a test was performed in which 400 men were divided in two groups. To one group was given reconstituted dried cabbage and the other boiled fresh cabbage. The group having the dried cabbage left less on the plates than the other group. Moreover, the vitamin losses in the process of pre-cooking, drying and re-cooking has been found to be less than the ordinary process of cooking. Dehydration has certain advantages than the other methods of preserving foods, particularly when considered in relation to vegetables. It extends the period and widens the area for use of a particular food. The chief drawback of refrigeration is that the material should be kept in refrigerated atmosphere till the time of consumption, whereas the outstanding merit of canning is longevity and that of drying transportability.

This may be explained with the help of the following table.

CABBAGE

	Weight in lb.	*Cubic ft. occupied*
Fresh	25	1·56
Trimmed	17	0·9
Dried loose	1	0·2
Dried blocked	1	0·03

The other advantages of dehydration are that no special sterilization is required and also the cost of the containers is very small as the product is much reduced in volume.

CONCLUSION

Whether food stored by modern methods is as nutritious as fresh food is a question which has occupied the attention of those concerned for some time past. There is so much to be learnt about food and nutrition that it is impossible to state categorically whether stored foods are as nutritious as fresh food. Many years of intensive work on large groups of human subjects would be required and even then it will be difficult to arrive at a definite decision. Nevertheless, useful information can be obtained by comparing the chemical composition of stored foods with that of fresh foods and the general conclusion can be accepted that relatively little loss occurs in foods stored by modern methods. Satisfactory nutrition has been maintained by animals kept on diets composed solely of preserved foods. From available data it can be suggested that modern method of storing food cause little destruction in their nutritive value. It can be concluded that food of good initial quality which has been stored by the best modern methods is likely to be superior in many respects to similar food that, though still technically fresh, is in reality stale.

Notes and News

POST-WAR INDIAN SHIPPING

THE second meeting of the Policy Committee on Indian Shipping was held in New Delhi on October 26, 1945, under the chairmanship of the Hon'ble Sir M. Azizul Haque, Commerce Member, Government of India. It was decided to appoint a Sub-Committee to recommend *inter alia* a suitable tonnage target for Indian shipping and measures to regulate the shipping industry in general. The Sub-Committee to be constituted, with Sir C. P. Ramaswami Iyer as chairman and Mr M. A. Master, Mr K. C. Neogy, Sir A. H. Ghaznavi and Mr W. L. A. Radcliffe as members, is to recommend (1) what would be a suitable tonnage target for Indian shipping to be attained within a period of five to ten years ; (2) what percentage shares of the maritime trade of India and other trades in which India is interested, both coastal and overseas, cargo and passenger, should be secured for Indian shipping ; and (3) what measures should be taken (*a*) to regulate the shipping industry with a view to (*i*) preventing the formation or establishment of combines or monopolies or excessively large units with the industry and (*ii*) to ensuring that the number of shipping companies operating is no larger than is economically adequate ; (*b*) to ensure a fair and equitable distribution, among existing companies and those yet to be established, of trades which may hereafter be secured for Indian shipping.

Sir Azizul Haque, in his presidential address, emphasized the strategic position shipping industry occupies in the economic life of a country in the modern world. India, with her vast coast line and long tradition in this industry, is most favourably placed with regard to any future development of the shipping industry. At the outbreak of the war, she had no more than 30 ships with a total of less than 150,000 tons gross. Her inability to find adequate shipping from her own resources to provide for the transport of the badly needed food supplies in this war when famine broke out in Bengal and other parts of India has been a pointer to the vulnerability of India's position in times of emergency. Sir Azizul rightly urged that "the acquisition of an adequate share in the world's carrying trade should be the aim of our post-war shipping policy, and to this end steps should be taken to secure for Indian shipping, (*i*) an increased share of the coastal trade, including trade with Ceylon and Burma (the present share is estimated at between 20-30 per cent.), (*ii*) a substantial share in the near trades, *e.g.*, Persian Gulf, East Africa, Malaya and Dutch East Indies, (*iii*) a fair share in the Eastern trades, especially those trades of which Japanese shipping will have been dispossessed, and (*iv*) a fair share also in the trade between India, on the one hand, and the U. K., the Continent of Europe and North America, on the other."

Indian shipping has been a notorious instance of Imperial Preference and of protection of British commercial and trading interests to the utter disregard of national interests. It is high time, particularly now that we have entered the first phase of the era of post-war reconstruction, that such Imperial Preference and policy of safeguard of foreign interests must end. Much as we agree with the above aim of post-war shipping policy in India, we are strongly of opinion that India should have cent per cent share in her coastal trade, and not merely 'an increased share'. Coastal and inland shipping has everywhere been recognized as the exclusive right of a nation. The foreign Government of India has so long denied us this fundamental shipping right and has refused to curtail privileges and monopolies enjoyed by foreign shipping companies in our coastal and inland waters. Coastal shipping is a national necessity, and it is the solemn responsibility of the Government to reserve it exclusively for indigenous shipping companies.

CONFERENCE OF MEDICAL OFFICERS

VARIOUS problems concerning medicine and public health in India came up for discussion at a four-day conference of administrative medical officers and directors of public health in the various provinces, recently organized in Delhi, under the chairmanship of Lt.-General J. B. Hance, Director-General, Indian Medical Service.

The methods of approaching, and the general policy to be pursued in tackling, the projects which lie ahead were discussed. Plans have been prepared to raise the standard of the existing medical facilities and public health measures, and to extend them with special reference to their availability to the poorer classes. The inadequacy of the nursing services was stressed by the delegates, and it was strongly urged that public opinion in India should grant to a nurse the social status and dignity freely enjoyed by these women in other countries.

Malaria as a major economic problem was considered in its many aspects. The conference

recognized dangers to public health, arising from construction operations connected with large engineering schemes and general industrialization. Such dangers, the conference suggested, can be removed by bringing such construction operations to the notice of the health authorities concerned before these are undertaken.

Medical education, post-graduate training, supplies of drugs and equipment and the possibilities of utilizing war surplus materials were also discussed.

The conference showed anxiety to uphold every medical and public health measure which would increase the standard of the individual's health throughout the country and thereby improve the general economic level.

RUBBER RESEARCH IN BRAZIL

IT is well known that Brazil was once the home of natural rubber and was one of the leading rubber-producing countries of the world until the appearance of the Far Eastern plantations. According to a report of the *Journal of the Franklin Institute*, August, 1945, the Brazilian Government has now been very keen on reviving this important and economic plantation. To this end, the Government established in 1941 a research institution called the Instituto Agronomico do Norte (I.A.N.), located in the rubber-growing area near the mouth of the Amazon. A type of leaf-disease particularly affecting rubber trees long stood in the way of successful plantation. Moreover, Brazil grows many types of trees yielding rubber of widely different characteristics. This involves systematic physico-chemical research and testing. The purpose of the I.A.N. is to undertake research in these and other problems connected with botany, pathology, physiology, entomology, technology, and economics of all agricultural processes and products of the Amazon valley.

The I.A.N. works in close co-operation with the U. S. Department of Agriculture and the Bureau in the U. S. A., and also with the Ford Rubber Plantation in Brazil. By grafting a bud from a tree with a good yield of latex to one with a strong root system, the institute has produced a tree, resistant to leaf-disease and capable of yielding much greater rubber than the average wild rubber-tree of the jungle. An optimistic view is that, with a good system of rubber research and technical schools established in the Amazon valley, Brazil should be able to increase her rubber production and compete favourably in price and quality with both natural rubber of the Far East and the synthetic product of the United States.

FOOD SUBSIDY

MR Darab Cursetjee Driver, in his presidential address at the third annual general meeting of the Engineering Association of India, gave a sweeping review of some of the outstanding post-war problems facing and distressing India today. He began with the new outlook created by the release of the atomic energy and referred to the problems of controls, black market, taxation, unemployment and its partial remedy by food subsidy, foreign capital investment in India, India's sterling assets and other questions bearing on the industrialization of the country. Admittedly, one of the serious problems to be grappled with is widespread unemployment consequent upon the cessation of hostilities. This problem cannot be immediately solved, although starting of such projects as road-making, hydro-electric construction work, building construction and development of new industries may to a small extent, if at all, ease the situation. Mr Driver advocates the subsidization of food as a palliative, as by this process prices of food stuffs can be kept down and unemployment made bearable. He said, "After the 1st World War, unemployment was bearable because food prices had not increased much. Unemployment when rice was 8 to 10 seers per rupee was tolerable because the unemployed could manage to live on the income of the earning members of their families, but with rice at 2 to 2½ seers per rupee, the unemployed would seek desperate remedies. France has recently announced a food subsidy equivalent to 110 million pounds. The progressive State of Mysore has provided in the current year for a food subsidy of Rs. 25 lakhs. The United Kingdom spends on food subsidy at the rate of £250 million a year."

Thus, even in India, Mysore has already set the example of food subsidy, with the result that the ceiling prices of rice and millets are about the lowest in India, barring a few producing areas in Madras and one or two other provinces. It stands to reason, therefore, that food subsidy should be immediately resorted to throughout India as a palliative against the scourge of unemployment before it gains sufficient momentum.

ECONOMIC MINERALS BUREAU

THE 21st annual general meeting of the Geological, Mining, and Metallurgical Society of India was held in Calcutta at the Royal Asiatic Society of Bengal on the 24th September last.

Referring to the proposal for the establishment of an economic minerals bureau (see SCIENCE AND CULTURE, X, p. 427), Sir Cyril S. Fox (the retiring President) said that the case of such a bureau was one for immediate action. The bureau, among other things, was meant to provide efficient and properly qualified geologists, mine surveyors, mining engineers and metallurgical experts to firms seeking such technical personnel.

The idea behind the plan is further to supply accurate information relating to the mining and

metallurgical industries thoughout the world, and to carry on chemical analysis of mineral and metallic substances quickly, cheaply and efficiently. It is expected that such a minerals bureau should co-operate with any geological, mining or scientific institution and with the Government. If the bureau was organized on proper lines, it would be a paying concern and a business proposition.

Presenting the annual report, the Honorary Secretary (Mr N. N. Chatterjee) said that in spite of the existing Government institutions India need an economic minerals bureau like the one outlined by the Society without any further delay. It is also realized that there is enough scope for the successful functioning of the proposed bureau, within a non-official organization like the Geological, Mining and Metallurgical Society of India for proper and efficient development of India's mineral resources.

The organizing committee expects to have the full co-operation from the Government, and the business magnates and industrialists, who are directly connected with mineral development of this country.

Mr B. M. Birla who was the chief guest at the function said, "The industrialization of which there has been so much talk in the country, cannot be achieved until we have a much larger number of technically qualified scientists and engineers than we have at present." He expressed the hope that the Society would do all it could to bring an increase in the number of geologists, mining engineers and metallurgists so that their industrial progress would not be delayed for want of qualified men.

The following were elected to the various offices for the year 1945-46: Dewan Bahadur Mr D. D. Thacker, *President*; Mr Sushil Chandra Ghosh and Prof. S. K. Roy, *Vice-Presidents*; Mr N. N. Chatterjee and Prof. S. K. Bose, *Joint Secretaries*; Prof. B. N. Maitra, *Treasurer*; Prof. S. Roy, *Librarian*; Mr G. C. Chatterjee, Dr A. K. Dey, Mr Chand Mall, Prof. T. N. Muthuswamy, Dr K. P. Rode, Mr P. H. Pandya, Mr M. L. Shome and Prof. Daya Swarup, *other members of the Council*.

PLEISTOCENE FLORA OF KASHMIR

THE Karewas of Kashmir has drawn the attention of botanists in recent years. In 1934, Prof. B. Sahni, discovered some fossiliferous spots near the village Laredura (on the north-east slopes of the Pir Panjal Range) near Gulmarg (*Current Science*, 5, 1939). A year later, De Terra with Stewart made a large collection from a different spot and these are described in De Terra and Paterson's monograph entitled "Studies on the Ice age in India and Associated Human Cultures", (Carnegie Institution of Washington, *169*, 1939). Since then many more new localities are discovered and large collection of fossil plants is made by G. S. Puri of Lucknow University. Puri has made a comprehensive study of his own collections and also those collected by Sahni, Stewart, De Terra, Jones, Middlemiss, Godwin-Austen and Wadia comprising several thousand specimens. Investigation of these specimens throws considerable light not only on the significance of the temperate species in the pleistocene flora of Kashmir but also suggests changes of altitude and climate during the period.

The occurrence of *Woodfordia fruticosa* (at Laredura, 6000 ft. alt.), which is significantly absent from the modern flora of the Kashmir valley supports the view that the mountain range has been uplifted a few thousands of feet since the early pleistocene. This has resulted in cutting off the Kashmir valley from the north-westerly monsoons and thereby eliminating from it most of the tropical flora (*Jour. of Ind. Bot. Soc.*, *22*, 125).

The family Salicacae (salix sp. populus sp.) well represented at Ningal Nallah (Pir Panjal, 9000 ft. alt.) indicates that this part of the valley must have enjoyed a temperate climate essentially similar to the modern climate of the valley (*Proc. Ind. Acad. Sc.*, *22*, 88, 1945). Puri has further reported a flora of 62 genera and 122 species distributed over 34 families of Angiosperms (*J. I. B. S.*, *21*, 1944) from this area and has traced the history of the Lombardy poplar (Populus nigra Linn var. *fastigiata* Desf) in India in the light of palaeobotanical evidence. It is proved that the Lombardy poplar is indigenous to the Kashmir valley, (*Indian Forester*, in the press).

MINERAL RESEARCH IN INDIA

A SYMPOSIUM on "Mineral Research in India for Developing Mineral Industries" was recently held at Delhi under the auspices of the National Institute of Sciences of India.

Inaugurating the symposium the Hon'ble Sir Ardeshir Dalal, Member, Department of Planning and Development, Government of India, expressed the hope that the deliberations of this meeting would help the Planning Department in their post-war plans for exploring the mineral resources of India.

In his opening address, Mr D. N. Wadia, president of the Institute and Mineral Adviser to the Department of Planning and Development, Government of India, outlined the past, the present and the future of India's mineral resources. A large number of papers were presented for reading at the symposium that was largely attended by the Fellows and many distinguished scientists and specialists on the subject who took part in the discussions.

Messrs. A. O. Rankin, D.Sc., F.R.S. and P. Evans, M.A., F.N.I. in a paper on "Geophysical

Prospecting for Oil in India" referred in some detail the history of geophysical prospecting for oil in India, with mention of the scope and cost of the 1938-40 prospecting programmes of the Burmah Oil Company. In discussing the results, stress was laid on the necessity for a unified prospecting programme in which geological mapping, geophysical surveys of alluvial areas, and the drilling of information holes and test-well are all closely co-ordinated. P. Evans with W. J. Wilson also read a paper on the refining of petroleum in India and Burma.

Dr J. D. Graaf Hunter, F.R.S. and Brig. E. A. Glennie referred to the "Geophysical application of Geodesy".

Mr E. S. Pinfold of the Attock Oil Company referred to the scientific problems in the development of the oil fields in North-West India.

Prof. M. N. Saha, F.R.S. referred to his investigation on the "Measurement of Geological Time in India" by radio-active methods.

Prof. S. K. Roy of Dhanbad School of Mines, gave the results of the survey of the Mewar State, and discovery of zinc, lead, silver and glass-sand deposits in Jawar.

Dr J. A. Dunn presented the Geological Survey of India's Position in India's Mineral Development and the present and future position of ores and minerals in India.

Mr E. R. Gee dealt with the Economic Mineral of the Punjab, and Mr B. Rama Rao dealt with the Scope for expansion of non-metallic industries in South India.

Mr F. G. Percival estimated reserves of iron ore in the Singhbhum-Orissa field.

Dr Gilbert J. Fowler described the production of nitre (Potassium Nitrate) from ammoniocal waste.

Dr C. S. Pichamuthu of Central College, Bangalore, emphasized the role of universities in mineral research. Mr A. K. Ghosh of the Calcutta University, while describing the Diatomaceous Earth in Nicobar Islands, referred to the possibilities of exploring this mineral from India and pleaded for facilities being created for micropalcontological research in the universities in India.

Popular lectures were delivered on this occasion by Prof. M. N. Saha, F.R.S. on his experiences of Soviet Russia and by Prof. H. J. Bhabha, F.R.S. on the role of mathematics in the evolution of science.

NATIONAL PLANNING COMMITTEE

The National Planning Committee which recently met in Bombay (November 8 to 10) has issued comprehensive instructions to its various sub-committees, based on the changed conditions in the various spheres of the National Planning, resulting from the war.

Pandit Jawaharlal Nehru, Chairman of the Committee, who presided at these meetings announced that the Government of India have agreed to make available to the National Planning Committee, such reports and materials as may be useful for planning work of the Committee. Prof. C. N. Vakil, Economic Adviser to the Planning Member, was deputed by the Government of India to attend these meetings and he participated in the discussions.

The Committee considered the report of the sub-committee appointed in September last (see SCIENCE AND CULTURE, October 1945) on the objectives of the planning, developments that had taken place during war time and priorities that should be observed.

On behalf of the sub-committee it was pointed out that special stress should be laid on full employment being the goal of National Planning as well as on the scheme of social security. Among the new developments that have taken place as a result of the war the sub-committee mentioned the tremendous importance now being given to scientific and technological research.

The Committee considered the report of the sub-committee in detail, that resulted in the discussions related to sterling balances, dollar pool, foreign investments in India, disposal of surplus factories and equipment constructed for war purposes and the utilization of war time camp, hospitals, buildings, etc. for the purposes of rehabilitating village life.

In a memorandum, the Committee has dealt with subjects over 30 heads that include: the form of the future Government of India, the objective of National Planning, industrialization, research, public economy control in its various forms, labour control, conciliation, social problems, trade barriers in international co-operation in economic matters, national economy, sterling balances, foreign capital, defence industries, war time development, rapid industrialization on Russian model, social economy, consumer goods, protection to special industries, agricultural policy, irrigation, hydro-electric projects, food, housing, cottage and handloom industries and the distribution.

The memorandum added that this list does not exhaust the list of priorities. Social services and cultural conditions are very backward in this country and special efforts will have to be made for the rapid and intensive expansion, improvement and development of public health, education, facilities for travel and entertainments and other directions by cultural growth, social amenities, and public utilities.

The Committee has further drawn attention of the various sub-committees to new inventions and dis-

coveries made during the war regarding material, processes, scale of production, etc. which in many cases had revolutionized important industries, both in regard to production and distribution.

The Committee has emphasized the need for making scientific and technical research as an integral part of planned economy. Industrial research, the Committee maintains, should be comprehensively planned and linked with the development of industries and industrial research organization created best suited to the needs of individual industries.

The Committee suggests that India should build up as rapidly as possible, institutions which can give the highest type of scientific training of the most varied type and that India should send its men abroad for scientific training to meet the industrial needs of the country in the immediate future. It will be the duty of the national government to adopt necessary ways and means of securing the use of such processes or equipments invented during war for planned industry in India.

The various sub-committees have been asked to review their previous reports and submit their final conclusion within three months or earlier, when the Committee will meet again to consider these reports.

Besides Pandit Nehru, the Chairman and Prof. K. T. Shah, Secretary of the Committee, the following members were also present: Mr J. R. D. Tata, Dr John Mathhai, Mr Walchand Hirachand, Col. Sokhey, Mr A. D. Shroff, Mr Manu Subedar, Mr Shuyab Qureshi, Dr V. S. Oube, Sir C. V. Mehta, Mr G. P. Hutheesingh, Prof. C. N. Vakil, Mr Ambalal Sarabhai, Miss Mridula Sarabhai, Mr. R. S. Ramachandra Iyer, Mr A. K. Shaha, and Prof. Radha Kumud Mukherjee.

AMERICAN DESTRUCTION OF JAPANESE CYCLOTRONS

THE alleged destruction of five Japanese Cyclotrons used for nuclear physics research by Allied troops at 10 A.M. on the morning of the 24th November, acting under General McArthur's orders has caused widespread shock and regret on this part of the globe, and we have been recepients of many letters of protest from all quarters. We quote from a letter received from Chinese quarters:

"This news has been a profound shock to Chinese scientific opinion for no less than fourteen years Chinese scientists have been under the attack of Japanese aggression, and the progress of physics in China has been inhibited and almost crushed, though a body of first class talent among the Chinese remains. Justice would have suggested the dismantling of this expensive apparatus and the handing of it over to the Chinese for reassembly and use in fundamental research. Only a few days ago a committee formed by the Chinese Government to foster such research held its first meeting. The apparatus can hardly have been so large as to have been of military significance."

These Chinese scientists have supposed

"That the Allied Powers made a clear distinction between Japanese Shinto-Fascism and nascent Chinese democracy. It is now to be feared that the present action (whatever its real motive may have been) will carry to all Asiatic peoples the implication—lamentable and detestable—that a mastery of science on their part is even now not welcome to the Western Nations."

We would invite readers of SCIENCE AND CULTURE to express their views on this matter, and invite the Indian Science Congress to express their considered opinion on the action taken by the American occupation authorities in Japan.

NOBEL PRIZE FOR PHYSICS AND CHEMISTRY

The Nobel Prize in physics for 1945 has been awarded to Dr Wolfgang Pauli, a Swiss Professor and not to Dr Otto Hahn as announced in SCIENCE AND CULTURE, November, 1945.

(Prof. Otto Hahn, the German radiologist and discoverer of radio-active substances has been awarded the 1944 Nobel Prize for Chemistry).

Dr Pauli is at present at Princeton University in the United States.

'Pauli Principle' has been extremely useful for understanding periodical system of elements and for interpretation of their spectra.

The Nobel Prize in Chemistry for 1945 has been awarded to Prof. Artturi Wirtanen of Finland.

INDIAN SCIENCE CONGRESS ASSOCIATION

THE thirty-third annual meeting of the Indian Science Congress Association will be held at Bangalore from January 2 to January 8, 1946. Prof. M. Afzal Husain, M.A., M.Sc., F.N.I., will preside over the meeting. His Highness Sri Jaya Chamaraja Wadiyar Bahadur, B.A., LL.D., Maharaja of Mysore, has consented to act as the Patron of the meeting. Following is the list of names and addresses of the sectional presidents:

Mathematics: Dr Ram Behari, M.A., Ph.D., D.Sc., Head of the Department of Mathematics, University of Delhi, St. Stephen's College, Delhi.

Statistics: Prof. K. B. Madhava, M.A., F.N.I., A.I.A., Professor of Mathematical Economics and Statistics, Mysore University, Mysore. (Government of India Statistical Laboratory, Presidency College, Calcutta).

Physics: Dr S. Bhagavantam, D.Sc., Professor of Physics, Andhra University, Guntur.

Chemistry: Dr B. C. Guha, D.Sc., Ph.D., F.N.I., Chief Technical Adviser to the Government of India, Food Department, Division No. 3, Imperial Secretariat, New Delhi.

Geology and Geography: Dr H. Crookshank, D.Sc., Director, Geological Survey of India, 27, Chowringhee, Calcutta.

Botany: Dr B. P. Pal, M.Sc., Ph.D., F.L.S., Imperial Economic Botanist, Imperial Agricultural Research Institute, New Delhi.

Zoology and Entomology: Dr M. A. Moghe, M.Sc., M.A., Ph.D., Head of the Department of Zoology, College of Science, Nagpur.

Anthropology and Archaeology: Dr R. E. Mortimer Wheeler, F.B.A., M.C., D.Litt., F.S.A., Director-General of Archaeology in India, Simla.

Medical and Veterinary Sciences: Rai Bahadur K. N. Bagchi, B.Sc., M.B., F.I.C., D.T.M., F.N.I., Chemical Examiner to the Government of Bengal, Medical College, Calcutta.

Agricultural Sciences: Mr V. Ramanathan, Deputy Director of Agriculture, Madras Post Box 412, Triplicane, P.O., Madras.

Physiology: Mr P. De, F.R.C.P., F.N.I., Professor of Physiology, Medical College, Calcutta.

Psychology and Educational Science: Dr Indra Sen, M.A., Ph.D., Lecturer in Psychology, and Philosophy, Hindu College, Delhi.

Engineering and Metallurgy: Mr P. H. Kutar, B.A., B.Sc. (Hons.), M.S., Met. E. (U.S.A.), General Superintendent, Tata Iron and Steel Co. Ltd., Jamshedpur.

SCIENCE IN INDUSTRY

MASS SPECTROMETER IN THE ANALYSIS OF HYDROCARBONS

THE *Technical News Bulletin* (August, 1945) of the National Bureau of Standards describes the application of mass spectrometer to the analysis of complex hydrocarbon mixtures. The use of mass spectrometer for such analysis, hitherto exclusively carried out by chemical methods, is recent and guarantees a high degree of precision.

The molecules of the hydrocarbons, bombarded by 50 to 100 volt electrons within the mass spectrometer, are ionized and disintegrated into possible fragments which always maintain the same ratio for a particular hydrocarbon. The ratio is usually different for different hydrocarbons. The peaks recorded in the spectrum conform to the normal molecules as also to the various disintegrated fragments. In the case of a mixture of several hydrocarbons, the fragments of each hydrocarbon give rise to their characteristic peaks which can be carefully analyzed and identified. It is reported that mixtures containing over 200 compounds have been precisely analyzed at the National Bureau of Standards. The agreement of results of individual analyses is high. Independent analyses have been found to agree to within a few tenths to a few thousandths of 1 per cent for the concentration of each component. The accuracy in such analysis is determined to an appreciable extent by the purity of the materials used for calibration and by a number of other factors. In test analysis, however, where the composition of the sample is known, the accuracy certainly lies within the limits of uncertainty in the given sample.

Small quantities of hydrocarbons, say 0·01 milliliter, are sufficient for mass spectrometric analysis. Although an advantage in many respects, the use of small quantities of the sample cannot always guarantee that representative samples have been analyzed. Several front-rank American oil companies have introduced this new technique in their testing laboratories. The members of the Indian Scientific Mission, during their visit to the U. S. A., had an opportunity of studying the application of mass spectrometer for such analysis, and they gave out in their addresses that the instrument can do what 50 chemists can do in the same time.

HELIUM DETECTS MIGRATION OF OIL

THE underground migration of mineral oil and gas is a vexed problem before the petroleum industry to-day. Extensive investigations have recently been undertaken in the U. S. A. to evolve a suitable method with which to secure accurate information

regarding such migration of oil. Successful application of helium as a tracer gas, developed by the Bureau of Mines, in co-operation with the Navy Department's Office of Naval Petroleum & Oil Shale Reserves, is reported in the *Review of Scientific Instruments*, September, 1945. The method consists in injecting the inert gas into the underground reservoirs of natural oil and gas through well bores drilled at carefully selected locations and then studying the concentration of helium in the natural gas from adjacent wells at measured intervals of time. From a knowledge of the concentration of helium and of the length of time required by the gas to travel through the intervening distances between wells, petroleum geologists can chart underground reservoir conditions with a fair degree of accuracy and ascertain the nature of drainage of the gas and oil through porous rock.

The chemical inertness of helium has been the reason for its selection as a suitable tracer gas. It does not stand the risk of being lost by combination with the reservoir rocks or fluids, and can be readily identified. The use of helium for the detection of underground migration of oil and gas is, however, still in its infancy. But the method, it is believed, bids fair to make possible the difficult study of subsurface reservoir conditions in a satisfactory and reliable way.

RADAR IN NAVIGATION

SHIPS provided with radar equipment can now steer in all weathers, fair or foul, according to a report of *Scientific American*. With the help of the new "eyes", the navigators have no difficulty in detecting obstacles such as lighthouses, buoys, icebergs, derelicts, approaching ships, and land within distances up to 30 miles in complete darkness and in the midst of fog and storm.

From the rotating antenna of the radar equipment, located on the top deck of the ship, powerful microwaves capable of penetrating fog or any other atmospheric conditions which seriously limit normal visibility are radiated to locate probable obstacles in the ship's path. The waves are actually sent out as "pulses" or surges of extremely short duration and at a very rapid rate. The obstacles reflect or scatter the microwaves which are received by the same rotating antenna to be subsequently amplified and registered as bright spots on the face of a cathode ray tube. The position of these spots can be viewed on the screen against a series of concentric "marker rings" which enable the distances of the objects to be measured within an accuracy of about one per cent.

The operator can also change the scale of the field to cover either 2, 6, or 30-mile radius. As the ship approaches an obstacle, the viewing range can be reduced from a radius of 30 miles to that of 6 miles and finally to a 2-mile radius to obtain larger scale chart and locate the obstacle with greater accuracy.

Developed by the General Electric engineers, such "eyes" are reported to be the first civilian application of radar, which is calculated to greatly minimize navigation hazards in future.

STRESS CORROSION

THE papers contributed to the recent symposium on "Stress Corrosion Cracking", jointly organized by the American Society for Testing materials and the American Institute of Mining and Metallurgical Engineers (Nov.-Dec. 1944), form a milestone in the present advancing field of research on stress corrosion. The symposium, in which twenty papers were presented, dealt comprehensively with all aspects of "spontaneous cracking resulting from the combined effect of high, prolonged stress and corrosive attack." Deterioration resulting from penetration by molten metals also formed part of the discussion.

In the introductory paper, the main facts revealed by research on stress corrosion are vividly brought out by describing the effects of corrosive attack of both mild and severe type on a wide variety of metallic materials, subjected to high tensile stresses. Methods of eliminating the locked-up stresses usually encountered in welded structures, such as heat treatment, regulation of precipitation hardening and metallurgical control of composition and internal structure of the metal, are described, and attention is also directed to the relative frequency of stress corrosion cracking under service conditions with emphasis on the limitations inherent in accelerated methods of test. The role of applied chemistry and metallurgy in the field of ballistics, which has developed considerably in this war, has been fully exploited in a number of papers dealing with the subject of stress corrosion, residual stresses and season cracking of small arms and ammunition.

In the domain of nonferrous metallurgy, one paper deals with the assessment of the susceptibility of aluminium alloys to stress corrosion wherein a report is given of the work done in the laboratories of the British Aluminium Co. Ltd. on the behaviour of stressed and unstressed alloys of aluminium subjected to both partial immersion in, and daily spraying with, a treated solution of sodium chloride. Another paper gives the results of stress corrosion tests on sheets of binary brasses, tough-pitch copper, copper-silicon and nickel silver alloys of varying compositions. It was found from these tests that, for most of the metals studied externally, applied bending stresses below the yield point (0·01% offset) did

not result in stress corrosion cracking. However, it was observed that failures could be traced in drawn and spun parts, formed brackets, bolts, studs, etc., where the material had been plastically deformed in the course of manufacture of the parts and subsequently subjected to corrosive attack either alone or in combination with an externally applied stress. In ferrous metallurgy, the subjects on the susceptibility of austenitic stainless steels and elevated temperature tension tests on galvanized steels received a good deal of consideration.

An exclusive programme is in prosecution at present in the laboratories of the United States Air Service Technical Command, Wright Field, Dayton, Ohio, directed towards the development of test methods for evaluation of stress corrosion susceptibility. The description of these investigations forms the subject of an interesting paper, wherein a detailed picture is given of the test methods, operation of tests, mode of stressing, types of specimen etc., adopted therein. Another paper dealing with stress corrosion in relation to aircraft components gives a factual survey of British experience on stress corrosion occurring in aluminium-rich alloys, steels, aluminium, magnesium-rich alloys and copper-base alloys.

Among the other topics dealt with are test reports on stress corrosion of cold drawn and heat-drawn bridge cable wires ; effects of protecting resin films on brass cartridges and the effect of a coating of polybutene on the fatigue properties of lead alloys.

While dealing exhaustively with the practical side of the work, the theoretical side has not been overlooked, the latter being discussed in two very informative papers. The first one deals with the correlation of published experimental data which have a significant bearing on the development of a theory of the mechanism of season cracking of brass. A review is given of the theories advanced upto now by eminent workers in the field, such as Heyn, Rosenhain, Moore and others, while information available on factors vital to a fundamental theory of season cracking is discussed under several heads such as influence of stress on cold work ; effect of microstructure ; grain-boundary potentials and season cracking ; correlation of elastic anisotropy with susceptibility to season cracking etc. An excellent bibliography of thirty five items supports the paper. The second paper deals with a generalized theory of stress corrosion of alloys and forms an extension of the current state of the theory and knowledge relating to the acceleration of corrosion by high constant stresses, (first reported in the *Trans. Am. Inst. Min. Met. Eng.*, 137, 11, 1940 *et seq.*) This paper discusses modern views on the electrochemical relationships between grain and grain-boundaries, the effects of stress on the corrosion factors and the directional effects arising from manufacturing operations, and draws useful conclusions. A considerable amount of data is also presented in support of an electro-chemical theory which is believed to be the clue in obliterating or at least reducing to a good extent stress-corrosion cracking. The modern theory of cathodic protection is also discussed at some length.

This symposium, like many others in the past, has brought about a deeper understanding of the phenomena underlying stress corrosion in varied metallic materials, and has helped engineers and metallurgists to probe deeper into the mysteries of metallic structure. By further investigation and research, the subject of stress corrosion can confidently be expected to yield results which would ultimately benefit the diverse branches of engineering and industry.

S. K. G.

THE SHARK-LIVER OIL INDUSTRY IN INDIA

B. N. BANERJEE AND V. SUBRAHMANIYAN

DEPARTMENT OF BIOCHEMISTRY, INDIAN INSTITUTE OF SCIENCE, BANGALORE

DURING recent years, a great deal of interest has centred round the production of shark-liver oil, especially on the West Coast of India. A useful volume of scientific literature has also grown up on the subject. The object of this contribution is to review the present position and to indicate some of the lines along which the industry should be planned and organized not only for meeting the post-war needs of the country, but also for holding its own against foreign competition.

India—once a Flourishing Fish Oil Industry

The fish-liver oil is no stranger to India. About eight decades ago, India exported quite large quantities to the West, Calicut being a big centre of production. Around 1870, the price of cod-liver oil fell below that of the Malabar fish oil and the Indian industry practically died out. Cod-liver oil from Norway and other countries began actually appearing on the Indian market in increasing quantities and the country became more and more dependent on foreign supply.

During this war, the German invasion of Norway, followed by British blockade, practically cut off that country from the rest of the World. The subsequent submarine warfare and the increased demands of the other nations kept India in short supply of cod-liver oil. Against this, the demands of the civil population and the fighting forces in the country for some suitable source of Vitamin A became quite considerable. An alternative source had to be found and, under this stress, the Malabar fish-liver oil industry was reborn.

The high Vitamin A, Potency of Indian Shark-Liver Oil

A great deal of credit is due to the Government organizations, as also the co-operating scientists, who helped to re-establish the industry. It was soon established that the liver oils from the shark and the saw-fish have a much high Vitamin A potency than cod-liver oil. Occasional samples have potencies of several hundred thousand International units per gram, *i.e.*, well over 100 times the potency of standard Norwegian cod-liver oil. The average potency is, however, of a lower order, though still distinctly higher than that of cod-liver oil. In some areas, an average of 30,000 units has been reported. In others, over 10,000 is found to be the average. We have examined genuine samples having a potency of between 5,000 and 6,000 units. A minimum potency of 10,000 units per gram has been suggested for the Indian Addendum to the British Pharmacopoeia and this may not be difficult to attain in practice. An oil of this standard will have about six times the potency of average Norwegian cod-liver oil.

According to the latest International standard, the average daily requirement of an adult would be about 5,000 units of Vitamin A. The majority of people in India get very much less than this quantity in their food. A large section of the population would require between 3,000 and 4,000 units as a supplement to make the required minimum. The supplement has to come in the form of fish-liver oils, vitamin or carotenoid concentrates etc., but very few actually get them. The majority go without it, with the result that gross deficiency manifests itself in different forms. Early blindness, tuberculosis and other wasting diseases are some of the ultimate consequences of such persistent deficiency. Apart from the millions who are thus afflicted, there are several millions more who show a sub-normal condition. In fact, it is generally recognized that there is more extensive deficiency of vitamin A than that of any other vitamin in India.

Potentialities are Considerable

India has a very long coast line amounting to several thousand miles. Of this, only a small part is actually being used for shark fishing. The possibilities of the rest of the coast, especially on the East, as also the use of other kinds of fish should be carefully studied. There will, of course, be need to blend, but as long as this is done under proper scientific supervision, no harm will follow.

Even with proper organization, it is too much to expect that the target of one million gallons a year can be attained in the near future. The supply of fish may not be adequate unless very special precautions are taken. In this again, State organization will be needed.

Fish liver oil is the most potent source of Vitamin A. In a country like India, with its large vegetarian population, fish-liver oil may not be acceptable to all. A considerable section of even strict vegetarians especially in South India—have no objection to the use of fish-liver oil as a medicine. Even these would prefer a vegetable source, if available. The Jains and certain other communities have very strong objection to fish oils. In any case, fish-liver

oils may not meet the entire country's need. The carotenoid pigments from vegetable sources must definitely be made use of to supplement the fish-liver oils.

A Target for Production

Granting that about 10 per cent of the population of India is to receive a supplement of 2,500 units per day of shark-liver oil (possessing an average potency of 10,000 units per gram), the total requirement of the country would be roughly a million gallons. If we make some allowance for the inevitable increase in population during the next decade and for an increased consumption by the people, the anticipated target of production would be about 2 million gallons. There is immediate demand for vitamining about 100,000 tons of hydrogenated oils made in India to meet the shortage of butter and ghee.

The Present Production

It is difficult to assess correctly the present production of the oil in India. Part of the production is under Government auspices and part through private enterprise. The oil is not usually marketed as such, but in a diluted form. The Government requirement (including the requirements of the Army) may be placed at a million pounds of Oleum Vitaminatum possessing an average potency of 1,500 units per gram. This would correspond to about 15,000 gallons of oil with a potency of 10,000 units. Some quantity has been exported outside the country, to China and elsewhere. In addition to this, there is the internal market in the country, but its off-take is not likely to have been so large as that of the Government. In fact, it is known that many of the big producers supplied their oil exclusively to the Government. Allowing a liberal margin for everything, it is unlikely that the present annual production of shark-liver oil from all sources could be very much more than 35,000 gallons. Even this may be an over-estimate.

There is evidence to show that all the oil is not derived from genuine shark or saw fish. The Governments and some of the reputed distributors are exercising some control, but the others are not so particular about it. We have examined specimens of oil containing only about 300 units per gram. These have subsequently been traced on the civil market, in a further diluted form, as standardized shark-liver oil. Such products are quite worthless, and it is regrettable that quite large quantities of these have been imposed on the already deficient civil population. This kind of thing is inevitable when there is no adequate drug control. At the same time, it must be remembered that even the lay public will not be slow in realizing that they have not benefitted by the use of such oils. There will inevitably be a reaction not only against the spurious brand, but other Indian makes as well, however genuine the latter might be.

It has already been mentioned that even genuine shark-liver oil may show considerable variation in regard to potency. This is due to a number of factors, the most important among which are the season, the age and the size of the fish. The locality also seems to be a factor. The fish does not synthesize the vitamin, but only elaborates it from what it eats. The marine biologists have already collected a good deal of data bearing on these aspects: but in actual practice it is very difficult to apply them. The collecting and processing centres are far flung and it is not always possible to exercise the necessary control.

At the collecting centres, payment is made either on the basis of the weight of the liver or the volume of the oil. Both of these are defective. Payment should be on the basis of vitamin content, so that all concerned could aim at quality rather than quantity.

Indiscriminate Fishing is Harmful

Some zoologists keenly interested in the development of the industry have expressed considerable apprehension in regard to the future chiefly because of the indiscriminate fishing that is going on. Even very young sharks naturally are being fast destroyed without any appreciable benefit. It has also been pointed out that the spawning seasons should be avoided, for otherwise the useful fishes will eventually disappear. It has, in fact, been argued by some authorities that, at the present rate, it may be difficult to maintain even the existing supply. This may be undue pessimism, but the warning from such authorities has to be borne in mind when planning for the future.

The Present Methods require Improvement

At the present time, the industry depends largely on the efforts of fishermen who sell their material either to Government agents or to private contractors. The buyers either process the livers on the spot or, as more often happens to be the case, pack them in salt or other preservative and send them over to the factories for extraction of oil. Under the existing conditions, freezing would not be feasible. Even salt preservation should prove adequate, provided there is not much lapse of time between the catch and the preservation on one hand and preservation and extraction on the other. Normally putrefactive changes set in rapidly, liver being very readily attacked. The changes are naturally very rapid under the warm tropical conditions. Added to this, the liver is a store house of digestive ferments which, though classed as non-living, can yet produce very profound changes even in presence of the salt. Under the existing con-

ditions, it is not uncommon to find a lapse of one to two days between different operations. This should be regarded as being too long. The oil increases in acidity, and putrefactive matter accumulates in the medium. On extraction, the oil is more smelly than it need be: it also tends to go rancid on standing. The vitamin is also steadily destroyed, so much so, that often standing for a year or two, many of the samples of oil contain only a negligible amount of vitamin.

Need for Protecting the Vitamin

The destruction of vitamin A in shark-liver oil has been studied carefully. The factors mentioned in the foregoing paragraph are very important in determining the rate of destruction. There are also other factors such as the nature of the container, diluent used, temperature, exposure to light, access to air and moisture and so forth. Even with the greatest care, it would not be possible to completely avoid destruction of vitamin. It is considered necessary, therefore, to add small quantities of protective agents (anti-oxidants), some of which are extremely potent in their action. Several anti-oxidants are mentioned in literature. Most of them are quite harmless at the concentrations to be used. They can be used singly or in certain combinations; in the latter case, the beneficial effect is disproportionately increased (synergistic action). With such protection, the vitamin will remain stable for at least five or six years—if not more—during which period the oil may be reasonably expected to be consumed.

The use of anti-oxidants as vitamin A stabilizers is well known and extensively used. Many of the well known brands of cod-liver oil preparations owe their sustained quality to the use of such protective agents. Some imported brands do not of course contain them with the result that their vitamin contents are not what they are claimed to be. In the interests of the Indian industry, it should be definitely made a policy to recommend and to insist on the use of the least harmful and the most effective among anti-oxidants.

The methods of collection and processing do of course, require a good deal of improvement. Under the existing conditions, it will be difficult to introduce some of the improvements. If sufficiently big vessels could be used and if the livers could be extracted on the vessels themselves within a very short time after the catch, as is generally the case in the preparation of cod-liver oil, a great deal of the subsequent difficulty could be avoided. Alternately, vessels fitted with refrigerating equipment could be used. This will require State support and organization.

Shark-liver Oil requires Supplementing with Vitamin D.

The cod-liver oil is naturally rich in Vitamin D. In that oil vitamins A and D are so proportioned that no further supplementing is needed. In the case of shark-liver oil, vitamin A is very predominant so that further supplementing of vitamin D will be needed to render it more balanced. Fortunately, concentrated Vitamin D preparations like Calciferol are easily available at relatively small cost, so that it should not be difficult to supplement shark-liver oil with Vitamin D at the blending centres. Considering the importance and the inter-relation between these two fat-soluble vitamins, it should be made a State policy to insist on the supplementing of shark-liver oil with Vitamin D before marketing.

Vitamin E is another important fat-soluble vitamin. It is not, however, very much missed in the average Indian diet which includes a good proportion of vegetable oils, whole seeds and so forth. It may not be necessary to add this vitamin to fish-liver oils, though it may indirectly help by acting as a stabilizer. In the case of carotenoid concentrates, however, the presence of this vitamin is considered necessary both as a stabilizer and as an auxiliary for the better use of the vitamin.

Shark-liver Oil need not be Diluted

During the first few years of the shark-liver oil industry, it was considered desirable and necessary to dilute the vitamin A content to the same level as in cod-liver oil. Groundnut oil was largely used for this purpose. This practice led to a number of secondary difficulties. It also facilitated the marketing of a number of spurious products. A good section of people find groundnut oil disagreeable; they do not use it even for cooking. Taken on the whole, it is now being increasingly felt that there is no need to dilute the shark-liver oil. The concentrated product can be used as such, the dose being reduced in proportion to the concentration. Used in that manner, the oil will also be less disagreeable. That is how halibut oil, another rich fish-liver oil is being used throughout the world.

Molecular Distillation may not be Necessary

Even when used in drops, any fish-liver oil has a disagreeable smell. Several ingenious methods for taking such oils along with food have been suggested, but even then the more fastidious people cannot miss the smell. It has been suggested, therefore, that the vitamin in the oil should be concentrated free from smell. This is a very desirable object, but there seem to be some practical difficulties in the way. The principle of molecular distillation employed for the

separation of the vitamin is well known and there are a number of small stills in different parts of the world. So far as we know, there is only one big still in America, which is actually being used for the distillation of shark-liver oil on a commercial scale. The erection of such a still at some central place in India may not be feasible unless collaboration on a comparatively favourable basis can be established.

Suitable packing will get round the Smell Problem

Modern methods of packing have been steadily getting round the difficulty of smell. Today there are several brands of vitamin preparations in the market which are so pleasantly coated that the smell, if anything, is quite agreeable. Such vitamin preparations which often include a number of vitamin can be swallowed without any discomfort. There is also no unpleasant after-smell. If the same pleasant smelling capsules are bitten through, the strong smell of the fish oil can be noted. Judging from the smell and concentration of the vitamin, it is easy to make out that either halibut oil or shark-liver oil of the necessary high potency is being used. Molecular distilled, odourless vitamin is still not being used on a large scale even by the most reputed firms. If proper methods of packing are employed, the smell difficulty can be completely eliminated even when using the raw fish oils.

Even with the present methods of production, it should not be difficult to collect together substantial quantities of shark-liver oil having an average potency of 30,000—40,000 units per gram. Of such an oil, only about a drop will be required for meeting the daily supplementary requirement of an adult. If the calculated quantity can be properly packed in attractive capsules, the entire needs of the more fastidious section of the public can be easily met. In addition to this, there will always be the less concentrated product, the daily dose of which will be a few drops. This can be easily taken if suitable dropping arrangement can be provided.

Difficulties in the way of the Healthy Development of the Industry

Judging from the trends of recent years, the biggest obstacle in the way of healthy organization and scientific development of the industry is the existence of a number of independent bodies which work rather isolated from each other. Provincial Governments, States, manufacturing concerns and others all work without sufficiently close contact with each other. Though it is not openly expressed, there is also a feeling of unnecessary rivalry with a tendency to observe secrecy in regard to the experience collected by each organization. As a result of this, there is no useful exchange of ideas between the major organizations. Each organization has its own separate agency for advertising, marketing, etc. This state of affairs stands in the way of healthy development. It also provides scope for the less scrupulous section of traders, who are under no control, for marketing all kinds of products as genuine articles. For want of proper co-ordination and concerted effort, the reputation of the industry as a whole is suffering. Even patriotic-minded medical practitioners are now hesitant about recommending Indian shark-liver oil. Doctors with some professional reputation are very zealous about guarding them: they are naturally inclined to be conservative in the recommendations to their clients. Patriotic considerations cannot weigh much in the alleviation of suffering. The present position should, therefore, be realized in its proper perspective. The Norwegian cod-liver oil (with its high reputation) and other well known brands will soon be on the Indian market and unless the shark-liver oil industry unite in facing this competition, it will soon die again, just as the Malabar fish-liver oil industry died about 80 years ago. Instead *of expanding, the industry is in danger of extinction, and it is earnestly hoped that this common danger will bring all the diverse elements together and pave the way for organized planning and development.*

There is no need for any Secrecy

At the heads of different provincial or State organizations there are administrators. They are naturally guided by their technical staff. The technical are inclined to keep rather close and this has created, even in the minds of the administrators, the impression that there is something of a specialized nature which must be preserved confidential for the benefit of their unit. *There is, in fact, no need for the preservation of any secrecy in regard to the methods of production and stabilisation.* The really important factor is the supply of fish liver and if the fishing areas can be properly demarcated, there is no aspect regarding which any secrecy need be maintained. In the interests of all concerned, there should be free exchange of notes. There should also be unified control to see that proper methods are followed. The standardization and marketing can also be under joint auspices. No interest will suffer under such conditions. Fraud will be stamped out and the industry will flourish under healthy conditions. The industry can also present a unified front to secure the necessary measure of protection against unfair foreign competition.

A Central, Co-ordinating Authority is needed

As already mentioned, the production is now going on under diverse auspices. These are not

normally likely to meet unless the Central Government takes some initiative in regard to the matter. Even when they meet, they should do so with a determination to work together.

Independent organizations cannot exercise any effective control unless they decide to create a central authority. The central authority should command their full confidence and at the same time, have the necessary freedom to plan and carry out the future development.

Composition of the proposed Central Authority and their powers

For the development of the shark-liver oil industry, what is needed is a small Central Authority consisting of a highly experienced administrator, who will also represent the Government, a reputed member of the industry who will advise on all business matters, and one scientist with the requisite standing and experience. The Authority which would work whole-time, should be charged with the planning and development of the industry for the whole country and they should be given the targets with full powers to take the necessary action. Every province or State with a coast line should come under their purview. After organizing production, the share of benefit for each individual province or State can be easily determined. The work of the Authority can be periodically reviewed by a bigger organization.

The present note does not claim to be a plan. It only aims at taking the position a stop beyond the fixing of a target. It draws attention to some of the outstanding problems and suggests a way of dealing with them. A specialized whole-time body such as the proposed Central Authority is needed to go into further details and to draw up the detailed plans and to execute them. The planning and execution need not be separated.

In the preparation of this note, great care has been taken to avoid specific reference to any individual or organisation. There may no doubt be some difference of opinion in regard to matters of detail, but the main problems are all there and they must be satisfactorily solved if the industry is to survive and to flourish in the post-war period.

MEDICINE AND PUBLIC HEALTH

DRUG DEVELOPMENT IN WAR-TIME GERMANY

A report of *Science News Letter*, September 22, 1945, gives an account of some of the important developments in drug in Germany during the war. The German chemists developed a synthetic chemical called Periston as a substitute for blood plasma for the treatment of shock in their war wounded. Periston is a polymer, polyvinyl pyrrolidone, and resembles albumin in some ways. It is reported that over 300,000 units of Periston were used on military personnel, apparently without harmful effects.

For fighting infection in wounds, the Germans pinned their faith on sulpha drugs. Marfanil was widely employed for such purposes. A new sulpha drug, Globucid, behaving as sulphadiazine but having a lower cost of production, was produced in quantity. They also developed two other germ fighters, dibromo and tetrachloro compounds of Salicil, which are still under study.

German interest in antimalarial drugs did not flag during the war. Some of the anti-malarial drugs studied, such as a quinoline derivative called Sontochin, had some promise, but were clearly inferior to atabrine which was in large production in Germany during the war years.

Domestic poppies were used as a source of a pain-relieving drug when imports of opium were cut off.

Demand for hormones and vitamins, both synthetic and natural, greatly increased, and efforts were made to produce these in larger quantities. In several instances, technical improvements were made in their methods of production. Purity of drugs and final products, it is reported, was maintained with meticulous care.

STREPTOMYCIN FOR TUBERCULOSIS

A new drug, Streptomycin, found in an organism known as *streptomyces grisens*, which is neither a bacterium nor a mould, has been recently announced in the U. S. Press. Its reported action against tuberculosis has for the time being brought streptomycin to the fore, and, as it always happens in the case of a new comer, the drug has raised hopes and doubts among medical researchers.

Dr Selman A. Waksman and his associates of Rutgers University and the New Jersey Agricultural

Experiment Station discovered the drug in a mould like germ living in the soil. It resembles penicillin as a germ-killer and attacks certain germs on which penicillin has no pronounced action. Thus streptomycin has been found effective against such diseases as typhoid fever, dysentery, undulant fever, tularemia, whooping cough and plague, which cannot be controlled by penicillin.

Greater interest in the drug followed the announcement by Dr Waksman of his results that streptomycin can act against tuberculosis germs in the test tube and effectively controls tuberculosis in guinea pigs. The success of these preliminary investigations led Drs H. C. Hinshaw and W. H. Feldon, of the Mayo Clinic and Foundation, to undertake clinical experiments on human patients. The drug was administered to 34 patients suffering from tuberculosis by intermuscular injection every three hours for several weeks depending on the nature of the case, and interesting, though not always encouraging, results were obtained.

It appears that some serious forms of tuberculosis, such as tuberculosis of kidneys and bladder and miliary tuberculosis, respond best to streptomycin treatment. In two patients suffering from miliary tuberculosis, one of whom also had tuberculosis of the kidneys, skiagrams revealed striking improvement of the tuberculosis condition of the lungs. In four patients having tuberculosis of the bladder or kidneys, streptomycin treatment stopped excretion of tuberculosis germs within two to four weeks. Patients suffering from tuberculosis of the lungs showed improvement during the treatment, but developed the disease as before with the stoppage of the drug. Streptomycin did not seem to have any rapidly effective curative action in these cases.

The Mayo scientists are of opinion that streptomycin does not actually kill the germs and in that sense cure the disease, but that it arrests the growth of the disease. In many cases, it had no effect other than minor improvements and a little prolongation of the patients' lives. Streptomycin is comparatively free from severe tonic reactions, which distinguish it from other drugs of the sulphone family. Patients generally complained of feeling a little sick and of aching muscles at the site of injections. These mild reactions were also minimized by using purer variety.

The case of streptomycin as a remedy is, therefore, clearly doubtful, and it is warned that proved and effective methods of treating tuberculosis, such as sanatorium treatment and collapse therapy, should never be abandoned. (For further reference, readers may be directed to *Science News Letter*, September 20 and October 6, 1945 and *Nature*, Sept. 29, 1945).

PHARMACEUTICAL INDUSTRIES*

THE subject of Pharmaceutical Industries comprises all such industries which are engaged in the manufacture of products required by members of (*i*) the public health professions, *e.g.* the medical, veterinary and dental—for the treatment or cure of the ailments of man or animal and (*ii*) forest or agricultural departments, for preservation of the vegetable life.

The Pharmaceutical Industries, in the present form, are mainly the creation of the 20th century. The rapid advance in the basic sciences—chemistry, physics and biology—during the latter part of the 19th century and early part of the present century made it practically impossible for a physician to combine the duties of both a fabricator and a prescriber of medicines. The result was the bifurcation of the duties of the physician into two sets of people ; the pharmacists and the physicians. Wherever this division of labour did not take place, there was stagnation and deterioration both in the standard of treatment and preparation of medicines. The vast continent of Europe, the U. S. A. and Canada realised the impracticability of combining the functions of two professions into one with the result that both the medical and pharmaceutical professions made rapid progress and contributed to the enrichment of our knowledge.

In India, the indigenous systems of medicine—the Ayurvedic and the Unani—have clung to old traditions and refused to play the game. The result has been the stagnation of the above systems and even in this age of rapid and stupendous progress in the realm of healing art, the above two systems, which were in their own hay days the glory of India and Arabia, are steeped in ignorance, and sometimes, superstition. These systems have been based on empirical knowledge acquired for centuries and do contain much useful information but often mixed with data having no scientific basis at all. The modern research worker with an open mind must find out the truth and when that is done, these will naturally be amalgamated with the modern scientific system of treatment. A glance through the two pharmacopoeias, allopathic and ayurvedic, will disclose a great simi-

* Adapted from a talk by Dr M. L. Schroff delivered before the Calcutta Rotary Club on September 11, 1945.

larity between the modern and the old systems. In the present age of vitamins, hormones, synthetic drugs and biological products, we cannot ignore the vast accumulation of knowledge, the gift of modern sciences. To prescribe rice water, prepared from polished rice, supposed as a source of vitamin B complex, cannot stand the test of time. In ancient times when unpolished rice was the article of common diet and more concentrated forms of vitamins were not available, it was perfectly legitimate to use rice water as a source of Vitamin B Complex. But unfortunately, due to lack of study on the part of Ayurvedic and Unani practitioners, such unscientific practices are still followed.

Conditions for Proper Development of Pharmaceutical Industries

When we consider pharmaceutical industries from the modern point of view, we find that our country is very much behind times.

The following may be regarded as the prerequisites for the proper development of pharmaceutical industries in any country :—

(*a*) Well developed system of Pharmaceutical Education ;
(*b*) Availability of Trained Chemical Engineers ;
(*c*) Research Institutes ;
(*d*) Scientific Survey of Raw Materials ;
(*e*) State Control of manufacture, sale and distribution of Medicines ;
(*f*) Existence of Basic Chemical Industries ;
(*g*) Existence of Packing Material Industries ;
(*h*) National Transport Policy ; and
(*i*) National Excise Policy.

Pharmaceutical Education

Proper development of pharmaceutical education is essential for the rise and progress of pharmaceutical industries in any country. Technical personnel of high calibre is required not only for carrying on the routine work but also for the development of new schemes. It may be said that the standard of pharmaceutical education is a barometer of growth of pharmaceutical industries in any country.

In Germany, Switzerland, France, etc. the pharmaceutical education had developed to a very high level even at the beginning of this century, and we know that the pharmaceutical industries in these countries had made a mark for themselves when other countries were unheard of in this respect. In England, a degree course in Pharmaceutical Chemistry was introduced in the University of London only in 1924 which accounts partially for comparative backwardness of U. K. in the realm of pharmaceutical industries. In Soviet Russia also, after the last revolution, pharmaceutical education made rapid strides with the consequent growth of pharmaceutical industries.

In India, the real pharmaceutical education is practically still unknown though a beginning was made at Benares in the year 1932, and at present some of the Universities are offering courses in pharmacy, but the standard achieved so far can hardly contribute to the progress of pharmaceutical industries in our country. The lukewarm interest taken in the public health services of our country by both the Government and the educationists explain very clearly our backwardness both in education and in industry.

Chemical Engineering

Chemical engineering is one of such branches of engineering which is required for the development of pharmaceutical industries. Crores of rupees have been spent in the U. S. A. for founding schools of Chemical Engineering to meet the growing needs of the industries. In India, Chemical Engineers are practically non-existent and most of the institutions which claim to train people in chemical engineering hardly reach the level of trade schools in more advanced countries. This also accounts for the non-manufacture of even the common pieces of chemical apparatus and equipment in our country.

Present Institutes

There were research institutions in the U. S. A., U. K., and the various European countries before the war for carrying out both developmental work as well as the basic research work for finding out new products and improving the old ones. These research institutions whether attached to the Universities or Government Departments or industries could be regarded as the very heart of industrial progress of those countries. The manufacture of indigo in Germany did cost crores of rupees and the labour of scores of scientists for a number of years to bring about the necessary result. Once the thing was accomplished, the cost of production was gradually reduced and the world markets were captured by Germany. In India, the real researches in the pharmaceutical sciences are practically non-existent. Even the Government research institutions under some excuse or other often enter into open competition with manufacturers by manufacturing some very common items, leading to the neglect of basic scientific and industrial researches. The Indian Institute of Science at Bangalore, the Central Research Institute at Kasauli, the Guindy Institute at Madras, the Haffkine Institute at Bombay and various other institutions have started competing with the manufacturers in the manufacture of very common products. They thus dissipate the energy of their

research workers and waste the money of the tax-payers. It is unintelligible why such suicidal policy is being adopted by our various research institutes. As far as pharmaceutical industries are concerned there are no research institutes in India and practically no research work of any tangible value is being carried out.

Scientific Survey of Raw Materials

Raw materials for pharmaceutical industries are derived from:

1. Vegetable Kingdom, 2. Mineral Kingdom, and 3. Animal Kingdom.

Unless a scientific survey of raw materials available in a country is made it cannot be found out what products can be manufactured in the country. Our forest department did not take much interest in the 'minor forest product' of the country under which the pharmaceutical raw materials come. Where information is possible on the availability of raw materials, the specifications of the same are wanting. It is only very recently that a beginning has been made on the pharmacognostic study of crude drugs. Even the chemical and biological assays of many of the indigenous drugs have not been carried out. Consequently, while we think that India abounds in a large number of natural raw materials, we hardly know which of them are capable of being used properly or cultivated scientifically and which of them simply enjoy reputation without having any scientific background.

Besides the crude drugs, in these days of synthetic drugs, we require various raw materials obtained from coal-tar. While this subject is often talked about, no detailed study has been made and those who want to go in for this industry find it difficult to do anything in the matter. Until recently, most of the coal was distilled in crude ways and now while some of the by-products are being recovered, they are not available to the industry for proper utilisation. It may be mentioned here that even at the beginning of this century, the coal-tar industry had developed to a very high degree in Germany and, at present, also in the U. S. A., it has reached a high peak. England has usually been a back number in these matters and hence, had to depend for most of her requirements from abroad.

The raw materials obtained from the natural mineral sources are not many but even those which are needed, their proper survey has not been carried out by the Geological Survey of India, with the result that even the manufacture of inorganic drugs has not proceeded to the right length.

Regarding the biological products, the raw materials required are not many as most of them, *e.g.*, molasses, slaughter-house waste, etc., are the by-products of one or the other industries already existing in our country. The lack of technical skill and equipment is coming much more in the way than anything else.

Strict State Control over the Manufacture of Medicines

The professions of medicine and pharmacy are public health professions and are strictly controlled by the State in every country in the world. In the U. S. A., there is a Food, Drug and Cosmetics Act which strictly controls the manufacture and distribution of the various substances used for the cure or amelioration of the ailments of man or animal. Practically, all the European countries also have got Pharmacy and Drugs Acts almost on similar lines to prevent the manufacture of understandard, spurious and harmful products. Besides the above, there are also books of standards (Pharmacopoeia) in all the countries according to which various medicines have to be manufactured. Unfortunately, in India, so far there is no control in the manufacture and distribution of medicines. In India, the Drugs Act was passed in 1940, about ten years after the submission of the report of the Drugs Enquiry committee formed by the Government of India. Five years have elapsed since the passing of the Act and it may take at least 15 months more before the Act can be enforced as the final Drug Rules have not been gazetted as yet. In England, in war time, many amendments were made in the Drug Rules and new Acts were brought into being to safeguard the public health of the country. In India, under excuse of War, the promulgation of the Drugs Act has been held back for the last five years. Further there is no Pharmacy Act here and hence, the dispensing of medicines is uncontrolled. Because there is no Drug and Pharmacy Act in our country, some manufacturers do manufacture medicines of doubtful value with the result that all the manufacturers suffer in their reputation and the first class doctors still continue prescribing foreign medicines hardly knowing what they are doing. If the Drugs and Pharmacy Acts were enforced there will be no ground at all for the sale of such foreign medicines as are manufactured here. The backgroundness of the pharmaceutical industries, specially on this score, can be ascribed to the apathy of the Central and the Provincial Governments of India.

Next comes the question of false and misleading advertisements, which are also controlled in all the western countries. Accordingly, the advertising policy of the various foreign firms is different in their own country to that in India where the advertisements are uncontrolled. In every country, there are certain diseases which are forbidden to be adver-

tised and regarding others also, there is strict control. Of course, recently the venereal diseases advertisements have been controlled only in Bengal but the advertisers are finding easy way of circumventing the enactment. A look into the various advertisements of the medicines appearing at present in the lay press—dailies, weeklies and monthlies, will show that a medicament is advertised to cure a large number of ailments,—a statement which is practically untrue. Advertisement of medicines in the lay press to be used only on the prescription of doctors is a thing very common in our country. Worthless medicines with hidden formulas are sold and consumed by the members of the medical profession as well as by the public only on the basis of advertisement. In India, the Central Government always places the blame for non-control of advertisements on the Provincial Governments as this question is a provincial subject and hence, cannot be handled by them. The news papers and magazines in this country are as much guilty as anybody else for allowing their media to be used for propagation of evil. Unless a strong sense of public opinion is created in our country backed by State control, it is very doubtful whether the public could be protected from the ramifications of unscrupulous manufacturers and advertisers.

In this connection, it may be mentioned that in peace time, in countries like Holland and Denmark, the manufacture of vital medicines like, insulin, etc. was under State control and nobody was allowed to manufacture these except with the explicit permission of the Government. If we allow every manufacturer to manufacture everything, we simply add more to the inefficiency and increase the cost of production and sale. The vital medicines require very strict technical control and every manufacturer cannot afford to spend so much money for the same and hence, to have a proper return, its manufacture should be controlled and only one or two manufacturers in a country with adequate equipment and personnel, should be allowed to produce the product.

In the case of even common medicines, if the same is manufactured, say, in a tablet form, by a dozen or two dozen manufacturers and all of them are offering their products which are practically identical in nature and therapeutic effect, the cost to the consumer becomes much increased. Perhaps, it is not a hidden thing that the cost of the ingredients in any medicine is hardly more than 10 to 12 per cent and the same is true of the packing cost but the cost of advertisement and selling organization even in countries like the U. S. A. comes to about 27 per cent. This expense of advertisement has to be paid for by the consumer without getting any increased benefit by paying this extra cost. If there is a proper control of the manufacture of medicines and each manufacturer is asked to specialise in certain lines and not allowed to manufacture other items, this cut-throat competition in the selling of medicines would be eliminated and the medicines could be made available cheaply to the average man in the street. Due to this keen competition, even the discount allowed to middle men in the pharmaceutical trade is very high. It is astonishing to hear that in peace times some firms were paying in India upto 60 per cent discounts to the various stockists on biological products. This will show that we have been paying for necessities of life too high a price, only due to the mismanagement of the entire industry by the powers that are at the helm of affairs.

The pharmaceutical industry, unfortunately, is one such industry where the medicines go to the direct consumer through several middle men. The avaricious appetite of the proprietors of chemist and druggist shops, the medical men, and in the case of hospitals and dispensaries, the clerical staff, has also to be satisfied before the products reach the actual consumer. All these cost not less than 35 to 40 per cent whereas by a proper State control of the manufacture and distribution of medicines, the cost to the consumer could be cut down at least by 30 per cent.

Development of Basic Chemical Industries

The pharmaceutical industries depend to a great extent on the development of basic chemical industries which provide the raw materials for the pharmaceutical industries. In India, during the War some basic chemical industries have sprung up but still we are far behind in this line. Our pharmaceutical industry suffered much during the war period for lack of availability of raw materials from abroad and even now we depend much on imports. The development of the two basic chemical industries, *viz.*, the coal-tar and fermentation industries are vitally necessary for the growth of pharmaceutical industry.

Development of Packing Material Industries

While some beginning has been made in the manufacture of neutral glass in India still we are not producing neutral glass of high quality or other heat resistant glasswares. Further, manufacture of high class chemical glassware, fancy glass bottles, metallic tubes, etc., which go in for the development of the pharmaceutical industries is still in its infancy in our country. This side line has to be developed for the proper development of pharmaceutical industries.

National Transport Policy

Transport policy is a very important factor in the development of any industry. Dr P. J. Thomas of

the Government of India has stated in his report that freight from Orissa to London of Nuxvomica seeds was the same as the Calcutta manufacturers had to pay from Orissa. In foreign countries, the policies of the State and the authorities of land and sea transport and of industry are combined together for one single purpose, namely, that of improvement and expansion of the industries of their country, but the case being otherwise in India, it is high time that the policy was nationalised in the interests of our trade and industry.

Excise Policy

The imported goods once cleared at the port of entry can move without any let or hindrance to any port of India. But indigenous products are subjected to all kinds of controls from province to province. Excise being a provincial subject, each province enforces it according to its whims not thinking at all what disservice it is doing to the national pharmaceutical industries. Unless the Provincial Governments and the Central Government revise their policy, the trade in India-made spirituous goods is at a disadvantage in contrast to the trade in foreign goods. The duty on spirit even for medical use is very high. The lowest duty is about Rs. 8/- per bulk gallon of spirit whereas the cost of the same in peace time used to be only Re. 1/-. Thus it will be seen that the public has to pay a duty to the State even for falling ill. Of course, the hospitals and dispensaries receive duty-free medicines, but what about the general public? In this respect also our policy needs revision.

BOOK REVIEWS

Mass Miniature Radiography of Civilians (for the detection of pulmonary tuberculosis), Medical Research Council, Special Report Series, No. 251, His Majesty's Stationery Office, London 1945, Price 3*s*. net.

This Report is based on a survey conducted for research purposes on a few selected civilian groups numbering approximately 23,000 persons from 2 factories, a large office group and a Mental Hospital in Greater London by a team of 4 workers consisting of two tuberculosis physicians, a research worker and a radiographic technical expert. The survey was conducted in 1943.

The objects with which the investigation was taken up were threefold:

1. To discover the technical administration and social problems arising from civilian mass radiography, and to establish standard methods and procedures in order to assist those responsible for the routine of the national scheme;
2. To estimate the incidence of tuberculosis during wartime in various civilian groups and to assist the authorities by estimating the demands likely to be made on the tuberculosis surveys as a result of mass radiography; and
3. Possibly to throw light on the epidemiology of the disease.

The Report is divided into two parts:—Part I being a guide to the demonstration and technique of civilian mass radiography and Part II containing the statistical results of the survey with a discussion of the associated problems.

Part I of the Report deals with the development of mass radiography, equipment and personnel for an unit, approach to civilian groups, technical arrangement, working of the unit either in or without connection with a chest clinic and interpretation of the films in correlation with large-size films, where needed. Part II of the Report describes the methods used in the detection of cases including examination and bacteriological investigations, besides a consideration of the factors concerned in studying the epidemiology of the disease. A small but useful supplement to the Report has been provided by a specially trained worker containing the results of re-investigation of one of the factory groups one year after the first mass radiographic survey.

Prior to undertaking the work, the workers and technical personnel had to be trained and the working methods standardised. In conducting the bacteriological examination of cases, the sputum was examined for those who could expectorate sputum. If the sputum proved to be negative for tubercle bacilli, it was cultured on special media; for those where the direct film proved negative, laryngeal swabs were used both for examination as well as for culture. All positive cultures were tested for virulence by

animal inoculation. It was found that the culture of sputum and the culture of laryngeal swab both added substantially to the positive total obtained by direct sputum tests alone. Laryngeal swabs seemed particularly indicated where sputum was absent or unavailable. It was found to be hardly worth taking a laryngeal swab where sputum was available. It was further found that Jensen's modification of Lowenstein's medium was more sensitive than Nassau's charcoal medium.

Of the 23,012 cases radiographed or examined by miniature radiography, 4,720 belonged to a light engineering plant, 3,657 belonged to a light and heavy engineering firm, 10,903 were employees in various government offices and 1,564 were patients in a mental hospital and 198 composed the staff belonging to this institution. In all the groups, except the mental cases, "previously known" cases numbered approximately 0·4 per cent of the total. Cases showing newly discovered tuberculosis lesions requiring medical attention varied between 1·3 to 1·4 per cent, of which 0·3 per cent to 0·4 per cent were active cases needing immediate sanatorium or equivalent treatment. The sputum was found to be infective for tubercle bacilli by one or more of the methods employed in approximately 20 per cent of the cases showing x-ray lesions. About 5 to 6 per cent of the cases, examined by miniature radiography, needed a more detailed investigation by full-size films. The incidence of cases among the mental hospital cases is in a different category. It was already known that mental hospital patients showed a higher incidence of tuberculosis in the community. Newly discovered cases among this group numbered 3·5 per cent of the total x-rayed. If to this is added previously known cases constituting 1·5 per cent of the total, the total figure comes to 5 per cent. Sputum was found to be positive in 50 per cent of "known" cases and 24·5 per cent of the "newly discovered" cases.

From the analysis of cases in the non-mental group, it was noticed that there was a tendency for the incidence of total cases and of treatment cases to increase from young to older adult life in the males and to decrease with age in the females. In other words, taking account of their respective contributions to the population at risk, females supplied the majority of the significant tuberculosis cases at the younger ages and males supplied the majority of the older ages. These tendencies are consistent with the well-known influence of sex on tuberculosis mortality at different ages.

Of the 79 "treatment" cases derived from the three employed groups investigated in the survey, 29 denied any recent symptoms referable to their pulmonary condition. The symptoms admitted by the rest were cough with or without sputum, breathlessness, chest pain, lassitude, wasting, amenorrhoea, haemoptysis and laryngitis, either singly or combined. Thus the incidence of active tuberculosis without any symptoms is fairly high. The disease was found to be unilateral in nearly two-thirds of the cases.

A subsequent investigation among the first group of light engineering industry showed the presence of radiologically active lesions in 0·7 per cent, a year later, in those who were found to be negative by the M.R.C. survey a year ago. This finding indicates the need for intermediate examinations whenever suspicious symptoms are noticed. If this was done, then it would lead to the early detection of cases.

Quite a number of non-tuberculosis lesions (117) were revealed by mass radiography in the factory and the office groups, consisting of cardio-vascular lesions (32), bronchiectasis, pulmonary fibrosis and pulmonary collapse (29), chronic bronchitis, asthma and emphysema (13), atypical pneumonia (5), thoracic tumours (8), and hilar glands (4).

A number of interesting facts related to the epidemiology of tuberculosis came to the surface by the mass radiography survey. The index of tuberculosis had hitherto been indicated mainly by the mortality rate. As morbidity figures based on notifications were hitherto considered to be too unreliable, mass radiography was found to provide an opportunity for assessing morbidity more accurately.

As regards economic factors, it was found that the incidence of significant tuberculosis lesions among the highest economic grade was lower than that among the whole volunteer population by a statistically significant margin. It was also found that the total incidence of significant lesions and the incidence of treatment cases among the manual workers exceeded the corresponding incidence among the whole volunteer population by margins which were probably statistically significant. A similar inverse relationship between the severity of lesions and economic grading was also noticed. Thus not only mortality but also morbidity of the disease is subject to economic influences.

From histories obtained about recent or past contact with infective cases of tuberculosis, either in the home or in groups, it was noticed that previous contact with the disease was probably an important factor in producing both manifest and "radiological" tuberculosis in employed groups. From a study of the mental hospital cases, it was found that prolonged hospitalization led to fresh cases among the inmates. Further, contrary to previous observations, it was noticed that schizophrenia did not carry a predisposition to tuberculosis.

Experience has shown that if cases are detected in early stages, their survival rate up to five years can be raised to over 90 per cent. As some 35 per

cent of persons examined by mass radiography did not exhibit any symptoms, there is no doubt that mass radiography helps us to detect cases in early stages so that recovery and rehabilitation can be enormously increased and thus tuberculosis can be brought within the range of controlled incidence. It is, however, necessary for dependable work and reliable findings that the type of machine used, the technique of taking and developing of films and the interpretation of radiological and physical findings need standardization in order to have comparable data in all parts of the world. The cost per patient in mass radiography is only a fraction of that of taking large-size films. In a country where beds are still insufficient to take care of even the seriously ill population and knowing that a comparatively small fraction of such cases can hope to live for five years after discharge from tuberculosis hospital and sanatories, the use of mass radiography in sieving out the tuberculous population must be considered to be an essential component of cheap Public Health procedures in prevention and rehabilitation.

The Report under review represents painstaking and co-ordinated work which should prove useful to all who want to organise mass miniature radiography. It is a matter of regret that while other countries are proceeding ahead with their efforts to reduce the incidence of tuberculosis, India is still in one of the lowest rungs of the ladder. As an essentially initial step, the Government, the larger industrial undertakings and the Local Bodies should equip themselves with mass miniature radiography sets, but there should be concurrent provision of chest clinics and tuberculosis hospitals and for sanatoria to receive the "treatment" cases.

A.C.U.

An Elementary Text-Book of Inorganic Chemistry —by Ramani Mohan Roy, M.Sc. (Gold Medalist), Ripon College, Calcutta. Pp. 506. Published by The Book House, Calcutta, Price Rs. 3/12/-.

The present volume covers the syllabus of the I.A. and I.Sc. courses in Inorganic Chemistry of the Indian Universities. The author has succeeded in presenting the subject-matter in logically graded steps so that the beginners may not find any difficulty in following them. A special feature of the book lies in its emphasis upon the fundamentals and the avoidance of unnecessary details which are likely to burden the memory and bewilder the young mind. The book will undoubtedly be useful to those for whom it is intended.

P. R.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

JOSHI-EFFECT FROM THE STANDPOINT OF KRAMERS' DISPERSION FORMULA

The mechanism of the above phenomenon,[1, 4, 6] *viz.*, Δi an almost instantaneous[3] and reversible decrease of conductivity produced by irradiation of a number of gases especially chlorine, has been envisaged by Prasad[5] from the standpoint of Kramers' quantum mechanical theory of light dispersion. He postulates that ionisation is essentially an extreme case of excitation. From Kramers' equation, due to the operation of negative terms which are characteristic of the excited state, a decrease of the refractive index n under excitation is to be anticipated. It follows from this, and the well-known relation due to Maxwell *viz.* $n^2 = k$, where k is the dielectric constant of the medium, that a corresponding change in k; the corresponding electro-static capacity; and therefore, the conductivity i of the system under excitation by light, which last constitutes the Joshi-effect, should occur.

The above considerations imply that this *light-effect* refers to a change in the dielectric or displacement current as distinct from the ohmic or conduction current in the system. The following experiments were carried out in order to investigate the validity of this aspect of the theory.

A Siemens' ozoniser filled with air at 200 mm. pressure was fed with the output from a H.F. oscillator in the range 5 to 10 megacycles; the corresponding i was determined with a galvanometer actuated by a vacuo-junction introduced in the H.F. circuit. In a typical result, with a deflection of 46 arbitrary divisions representing i in the dark, irradiation with a 200 watt bulb and that from a large quartz mercury vapour lamp did not diminish i >0·5 division, which represented the degree of accuracy. When, however,

in a series of observations, a potential of 5.8 kv at 50 cycles frequency was applied, under both the above radiations, the deflection was reduced from 46 to 45 corresponding to a *light-effect* exceeding 1 per cent. This ozoniser was next filled with chlorine at 300 mm. pressure, which was found by trial to be about the optimum condition for this effect. A deflection of 61 in dark obtained due to H.F. remained unchanged under either of the radiations. That, however, as in the case of air, the effect occurs with a large enough applied potential and lower frequency (50 cycles) is shown by the following results:

	Hg vapour lamp			200 watt bulb		
kv	Deflection dark	Deflection light	Light-effect	Deflection dark	Deflection light	Light-effect
			$100\Delta i/i$			$100\Delta i/i$
6	5	1·4	47	4·6	1	45
6·7	9·2	2·5	48	8·2	2	46
7·3	14·5	4·4	45	13·4	4	49

The fact that the percentage *light-effect* $100\Delta i/i$, for both the series is practically the same, shows that most of the ultra-violet is absorbed by the glass-walls of the ozoniser, and that the visible light common to both is responsible for the production of the effect. This is in agreement with earlier results that at large intensities as in the present case, a change of intensity does not produce an appreciable change in the light-effect.[2, 4, 6]

These results prove that this phenomenon does not occur when the current is only of the dielectric type, and reveal therefore, a marked deficiency in the theory of Prasad.[5] A more appropriate approach is afforded by the general result due to Joshi[1, 3, 6, 7] that the discharge current depends chiefly on $V-V_m$ where V is the applied voltage and V_m the corresponding 'threshold potential; characteristic of the gas, the pressure and other operative conditions.[1] Joshi found that the effect of irradiation is to increase V_m.[3] From this Joshi predicted a diminution of current i on irradiation; this has been observed without exception in numerous cases and represents perhaps, the best method of a study of this phenomenon.[3, 6] Prasad's theory[5] also fails to account for the fact that the Joshi-effect does not occur below the 'threshold potential' V_m.[6] Production of this effect only when there is ionisation by collision suggests[2] that on irradiation a reduction of either, or both, the ionic velocity and the number of 'metastables' take place; or/and an increase in the corresponding rate of recombination of ions.[2] This latter is expected to be confined chiefly to three body collisions on the container walls.[2] This accords with the general observation of a pronounced influence of the nature of the container walls on the magnitude of the phenomenon.[2]

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P. B. Das Gupta

Chemical Laboratories,
Benares Hindu University.
Benares, 16-8-1945.

[1] Joshi, *Curr. Sci.*, *8*, 548, 1939.
[2] ——— Presidential Address, Chem. Sec., Ind. Sci. Cong., 1943.
[3] ——— *Curr. Sci.*, *13*, 253, 1944.
[4] Joshi and Deo, *Nature*, *153*, 434, 1944.
[5] Prasad, *Nature*, *155*, 362, 1945.
[6] Joshi, *Curr. Sci.*, *14*, 67, 1945.
[7] Joshi, *Trans. Faraday Soc.*, *23*, 227, 1927; *25*, 108, 138, 1929.

RECOGNITION OF SEX BY SECONDARY SEXUAL CHARACTERS IN *BUFO MELANOSTICTUS* SCHNEIDER

Besides the primary sex organs, the mature males and female individuals of various animals possess numerous structures which are characteristic of the particular sex and are known as the secondary sexual characters. These give rise to sexual dimorphism and greatly aid in the recognition of the sex of the animal without dissection and examination of internally located primary sex organs. In the case of Amphibia the secondary sexual characters have proved to be of considerable taxonomic importance and have been studied in detail in many species.[1] Alexander[2] described in detail the secondary sexual characters of *Bufo melanostictus* Schneider. Liu[3, 4] observed in Salientia a new secondary sexual character and he gave an account of these characters in the Chinese frogs and toads.

In the course of guiding students in the dissection of toads (*B. melanostictus*) certain features with regard to the secondary sexual characters in this species attracted the notice of the author and the object of the present paper is to record his observation on these.

The specimens were examined during the months of June to September, the breeding season of the toads. The average length from snout to vent of the specimens examined was about 3 inches and thus approximated the average measurement in length of a mature adult male as recorded by Alexander. An examination of the secondary sexual characters being made the specimens were subsequently dissected to verify these observations with the internally situated primary sex organs—the testes and also to note any particular feature regarding these organs. The measurement in length of

the individuals and the fully formed condition of the testes left no doubt that the specimens examined were mature adults particularly when they were collected and examined in their breeding season.

Observations were recorded on the following secondary sexual characters which according to Liu distinguish the male individuals of Salientia:

1. Modifications for grasping—These consist of the digital swellings. The two inner fingers of each forelimb are provided on the upper surface with pads.
2. Vocal sac—In this animal it is a black pigmented sub-gular sac. This lies just below the skin in the region of the throat and opens into the buccal cavity through a single asymmetrically located slit on the floor of this cavity.
3. Linea masculina—These consist of two deep elongated bands of connective tissue extending over the dorsal and ventral ends of the oblique muscles on each side of the body wall.

While describing 'the linea masculina' as a new secondary sexual character in Salientia, Liu states that these are present in *B. melanostictus* but in a later paper on the secondary sexual characters of the Chinese frogs and toads he states that this character is absent in this species. A search for this character in a number of freshly killed male toads was made but it could not be found in this species. It thus confirmed the latter statement of Liu. As 'the linea masculina' were not found, observations were therefore confined to an examination of the other two characters *viz.*, the modifications for grasping and the vocal sac, with a view to ascertain how far these characters helped in the recognition of the sex of the animal before examining the internally situated primary sex organs.

Modifications for grasping: In the breeding season the males gather in appropriate waters and begin croaking to attract the females. The latter enter the water where each is clasped by a male. The male toad mounts on the back of the female and firmly grasps with the forelimbs around her thorax, with the roughened pads on his inner fingers pressed tightly against her breast. The pads are present on the upper surface of the two inner fingers and as these muscular pads are special modifications for grasping during this stage they are also known as 'nuptial pads'. The pads vary in size and colour in the different individuals. The pads vary in colour from grey to intense black and the size of the pads is more or less directly proportional to the degree of blackness. In the breeding season, when the pads are actually used for the purpose of grasping, they are large and intense black. Those on the innermost fingers are larger in size than those on the other two fingers. Besides the pads on the two inner fingers, Liu describes that the third finger also bears on the upper surface another small swelling near its tip. But this could not be marked in many cases and in a few specimens where this was considered to be present, it was so small and insignificant that no importance could be attached to the presence of this one as a modification for grasping. Though the presence of digital swellings as modifications for grasping was described by Alexander as a consistent character, the writer found them absent in a number of individuals examined. Out of a total of 30 male specimens examined, these were absent in as many as 5.

Vocal sac: The sub-gular vocal sac is present in the males. It is developed as a membranous outgrowth from the floor of the buccal cavity and serves to resonate and amplify the croaking notes produced by the males to attract the females for mating purposes. It is a black pigmented sac. This black shows through the skin in the region of the throat though the degree of blackness varies to a certain extent in the different individuals. Contrary to the observation made by Alexander, the presence of the sac is easily noticeable in the living condition by this black pigment. In those cases where the digital swellings are absent this pigment noticed through the skin in the region of the throat is very helpful in recognising the sex of the animal. Where the pigment is not noticeable from outside it is probable that the sac is absent. The writer came across male individuals of average mature adult size where the vocal sac was absent. Neither Alexander nor Liu records cases where the vocal sac is not found. Out of a total of 20 male specimens examined, the vocal sac was absent in as many as 3 individuals.

The vocal sac opens into the buccal cavity through a single aperture. This opening according to Alexander is located more often on the right side of the tongue. The writer however could not find such a condition. In the specimens examined by him the opening was located in most cases on the left side of the floor of the buccal cavity to the left of the tongue.

In the absence of 'the linea masculina', recognition of the sex in male toads with the help of the secondary sexual characters depends on the presence of the other two features—the pads and the vocal sac. It is however observed that these two characters are not consistent and their occasional absence is apt to produce a wrong impression in the recognition of the sex of the individual at first sight. Out of 20 male specimens examined during the breeding season when these characters are particularly exhibited, the

writer found as many as 3 specimens, all of the average mature adult size, in which neither pads were developed, nor the vocal sac was present. Though the secondary sexual characters in amphibia and particularly in toads have been studied in detail by various authors, there is no previous record to indicate that these two characters are variable and that occasionally both of them may be absent. These individuals without pads and vocal sac were dissected and examined to note whether there was any special feature regarding the primary sex organs —the testes. The testes were found quite well-developed. In this connection it may be said that the Bidder's organs, which remain attached to the anterior ends of the testes and persist throughout life in males, were found in these animals without pads and vocal sac to be fairly large and hypertrophied. In the frog though the relation of sex hormones to the secondary sexual characters have been extensively studied, the subject is still in a state of considerable confusion.[5] It is probable that the hypertrophied condition of the Bidder's organ in these toads is correlated with the absence of the above named secondary sexual characters and further study into this aspect of the problem may throw more light on ascertaining the probable function of the Bidder's organ and its influence on the development of the secondary sexual characters in toads.

B. K. CHATTERJEE

Biology Department,
Presidency College,
Calcutta, 28-9-1945.

Noble, G. K., Biology of the Amphibia, 1933.
Alexander, G., *Copeia*, *47*, 1933.
Liu, C. C., *Journal of Morphology*, 1935.
———— *Zoo, Sr. Field Mus. Nat. His.*, *22*, 1936.
Holmes, S. J., Biology of the Frog, 1938.

THE AZIMUTHAL EFFECT OF COSMIC RAYS AT LAHORE

STUDIES on the azimuthal variations of Cosmic Rays at Lahore (22°N), previously reported by one of us[1], are being carried on with the cone of the telescope further reduced. The zenith angle of 60° has been kept constant as in the earlier runs of the experiment. The solid angle ranges covered in the first three runs of the experiment were 14·5°, 8·07° and 7·15° in the vertical and 65°, 38·87° and 37·93° in the lateral planes respectively. The solid angle range in the present run is 9·8° in the vertical plane and 26·4° in the lateral plane.

In Fig. 1 the curve represents the data collected at intervals of 10° of azimuth from the North-West quadrant, keeping the zenith angle of the telescope 60°. One of us[1] has already pointed out that

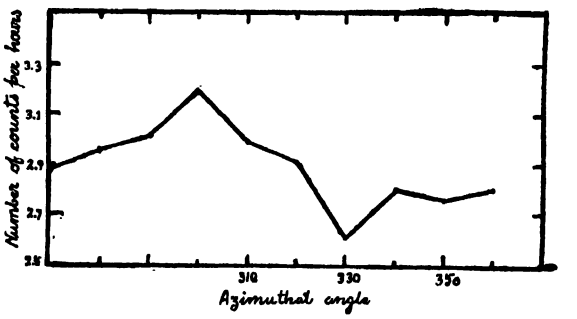


FIG. 1

for smaller and smaller cones the experimental curve seems to approach Hutner's[2] theoretically calculated curve. The present data confirm that view. If we compare the percentage differences between the maximum and the minimum points on the theoretically calculated curve to the experimental ones for two widely different cones having solid angles 14·5° and 9·8° in the vertical and 65° and 26·4° in the lateral planes respectively, the percentage difference between the maximum and the minimum points of the narrow cone is more than twice that for the wider cone. This difference is becoming larger as the cone is decreased which would mean that for a very narrow cone it would approach that shown by the theoretically calculated curve. More data are being collected with a further reduced cone having angles 5·3° and 14·2° in the vertical and lateral planes respectively.

We wish to express our thanks to the University of the Punjab for financial help towards this work.

P. S. GILL,
S. P. MALHOTRA

Forman Christian College,
Lahore, 3-10-1945.

[1] P. S. Gill—*Proc. Nat. Inst. Sc. India*, *9*, 251-52, 1943; *Phys. Rev.*, *67*, 347, 1945; *Proc. Ind. Acad. Sc.*, *22*, 53, 1945.
[2] R. A. Hutner- *Phys. Rev.*, *55*, 614, 1939.

GROWTH OF *BACT. COLI ANAEROGENES*

THE growth of *Bact. coli communis* with ammonia and several organic acids as the sole sources of carbon has long been observed.[1, 2] Certain preliminary experiments on the growth of *Bact. coli anaerogenes* (a non-gas former) are reported here as they seem to be of considerable significance in the elucidation of the mechanism of the synthesis of amino-acids and proteins by bacteria.

The protein content of *Bact. coli* is 80 to 90 per cent of the dry weight. The amount of total protein synthesised by this organism may therefore be taken as proportional to the amount of their total growth.[3] In our experiments growth in the initial phase has been measured by viable counting (pour plate method) with washed inoculum of 100-200 thousand organisms per cubic centimetre. The dicarboxylic acids and α-ketonic acids used here were sterilised by filtration through small well-burnt candles immediately before use.

It is of interest to note that oxalacetic acid initiates faster growth than either fumaric or malic acids in the presence of ammonium sulphate (2.5 mg. per c.c.), the growth being the least with fumaric acid. (Table 1).

TABLE I

GENERATION TIME IN THE PRESENCE OF C_4-DICARBOXYLIC ACIDS AND AMMONIA

C_4-acids (0·005 M)	Generation time in minutes at	
	6 hrs.	10 hrs.
Fumaric acid ...	178	125·2
Malic acid ...	119	99·6
Oxalacetic acid ...	69	70·3

This initial rate of growth with oxalacetic acid is also faster than that with either α-ketoglutaric or pyruvic acids. (Table II).

TABLE II

GENERATION TIME IN THE PRESENCE OF α-KETONIC ACIDS AND AMMONIA

Ketonic acids (0·005 M)	Generation time in minutes at	
	3 hrs.	10 hrs.
Pyruvic acid ...	917	115
α-ketoglutaric acid ...	307	98
Oxalacetic acid ...	276	90

Lactic, malic and succinic acids support growth in the presence of ammonia with or without glucose. Citric, aconitic, tartaric and malonic acids do not support growth with ammonia but largely accelerate growth only when glucose, glactose, arabinose or lactose is also added. This stimulation of growth by citric acid occurs anaerobically as well and is not appreciably inhibited by malonic acid or fluoride. Cyanide and arsenite, on the other hand, completely inhibit the growth of this organism. Citric acid also stimulates to a much smaller extent the growth with glucose in the presence of glycine or leucine. Succinic, malic or fumaric acids fail to stimulate in the same way as citric acid, thereby indicating that this stimulation was not according to the citric acid cycle.[4] Similar stimulation of *Mycobacterium* was reported earlier.[5]

Hydroxylamine, acetamide or guanidine fail to support growth in the presence of malic acid. Ammonia appears to be a better source of nitrogen than glycine in the initiation of the growth with oxalacetic acid. Leucine which is not determined by this organism supports growth with malic, succinic or lactic acids but not with citric or aconitic acids. Asparagine, aspartic or glutamic acids, on the other hand, cause approximately the same growth.

The foregoing findings suggest that oxalacetic acid occupies a central position in the synthesis of amino-acids by bacteria.[6] Aspartic and glutamic acids primarily formed cause the synthesis of other α-amino acids by transamination.[7]

Further work is in progress to study the intermediary metabolism involved.

N. B. DAS

Imperial Veterinary Research Institute,
Mukteswar-Kumaun, 8-10-1945.

[1] Koser, S. A., *J. Bact.*, *8*, 493, 1923.
[2] Quastel, J. H., *Biochem. J.*, *19*, 641, 1925.
[3] Mueller, J. H., *J. Bact.*, *29*, 383, 1935.
[4] Krebs, H. A. & Johnson, W. A., *Enzymologia*, *4*, 148, 1937.
[5] Edson, N. L. and Hunter, G. J. F., *Biochem. J.*, *31*, 563, 1943.
[6] Virtanen, A. I., *Nature*, *155*, 747, 1945.
[7] Lichstein, H. C. & Cohen, P. P., *J. Biol. Chem.*, *157*, 85, 1945.

ON THE LACTIC ACID FERMENTATION

THE production of lactic acid with good yields and that again in a short period by the fermentation of a suitable carbohydrate by one or other lactic acid bacteria depends on the kind, quantity and combination of the accessory nutrients.[1] It has been shown from this laboratory[2] that fermentation of molasses by *L. Bulgaricus* can be completed within 48 hours even when the mash is maintained at 37°C if a concentrate from liver be incorporated with the fermenting medium. In any commercial production attention should be directed towards the cost involved and as such an investigation has been undertaken to find out suitable accessory factors that may replace the liver extract partly or wholly in increasing the yield and rate of production of lactic acid.

In a recent paper Basu *et al*[3] have shown that a papain-digest of groundnut meal offers a suitable medium for the growth of various microorganisms. Accordingly a fermentation of cane sugar solution by *L. Delbruckii* with incorporation of various concentrations of groundnut meal extract was carried out at 37°. The fermenting mash consisted of 15 per cent cane sugar, 9 per cent calcium carbonate, various concentrations of liver extract and groundnut meal digest. In the table the latter are being respectively expressed in terms of raw liver and fresh groundnut meal. The rate of fermentation is being recorded in Table I.

TABLE I

Fermentation Temp. : 37°; Cane Sugar : 15%; $CaCO_3$: 9%

Expt.	Accessory Factor		% of Sugar fermented after hours			
	Groundnut Digest %	Liver concentrate %	96	136	150	180
1	4·0	1·25	72·4	99·8	—	—
2	4·0	0·65	31·0	54·0	—	99·4
3	2·8	1·25	71·7	99·6	—	—
4	1·6	1·25	60·7	84·0	99·7	—

From the above table, it appears that an optimum amount of liver concentrate with a certain proportion of groundnut meal digest increases the rate of fermentation (Expt. 3). It may be noted that the nutrients involved in lactic acid fermentation are mostly vitamins of B group[4, 5, 6] and, as such an extract of apical portions of the shoots of the creepers that are rich in vitamin B complex may also serve as a source of nutrients in lactic acid fermentation. Accordingly, fresh shoots of the plant *Lagenaria Vulgaris* (Bengali—*Lou*) were mixed with sand (equal part) and thoroughly macerated with water (two times the weight of the plant). The aqueous extract was centrifuged and the supernatant liquid was left overnight in refrigerator and then filtered through a candle. This sterilised solution gave no precipitate with trichloracetic acid, or phosphotungstic acid. The total solid content of the extract was 2 per cent on the basis of the weight of the plant. This extract was then incorporated in a fermenting mash containing various concentrations of sugar along with the groundnut meal digest. The rate of fermentation by *L. delbruckii* at 37° is being recorded in Table II. The figures against groundnut digest and *L. Vulgaris* extract indicate the amount of raw meal and fresh shoots used in preparing the respective digest and extract for each experiment.

TABLE II

Fermentation Temp. : 37°

Expt.	Sugar %	$CaCo_3$ %	Accessory Factor		% of Sugar fermented in hours	
			Groundnut Digest %	*L. Vulgaris* Extract %	48	96
5	5	3	5	25	90	100
6	10	6	,,	,,	75	100
7	15	9	,,	,,	72·6	97·6

From Table II, it would be evident that incorporation of an aqueous extract from *Lagenaria Vulgaris* helps in the rapid fermentation of the sugar by *L. Delbruckii*. The results recorded above are from average of three experiments and it may be recorded here that the extract from *L. Vulgaris* fails to accelerate the above rate of fermentation if it be heated at a temperature above 80°C. Further work is in progress to find out other sources of nutrients for lactic acid fermentation.

The author wishes to express his sincere thanks to Dr U. P. Basu for suggesting the work.

D. BHATTACHARYA

Bengal Immunity Research Laboratory,
Calcutta, 14-10-1945.

[1] Stiles and Pruess, *Jour. Bact.*, *36*, 149, 1938.
[2] Dey and Malakar, SCIENCE AND CULTURE, *9*, 559, 1944.
[3] Basu, Sen Gupta and Sen, *Ind. Medl. Gaz.*, Aug. issue, 1945.
[4] Snell, Strong and Peterson, *Biochem. Jour. 31*, 1789, 1937.
[5] Pan *et al*, *Ind. Eng. Chem.*, *32*, 709, 1940.
[6] Jackson & Thomas, *Ind. Eng. Chem.*, *36*, 261, 1944.

ON THE EFFECT OF WATER SUPPLY ON THE GROWTH AND DEVELOPMENT OF MUNG *PHASEOLUS RADIATUS* (LINN)

A PRELIMINARY experiment on the effect of water supply was set up with Mung I. P. 28 from Pusa. The seeds were sown in pots 7″ diameter and 7″ height on 26-3-45, each pot of Set I receiving 150 c.c. water daily and that of the Set II, 500 c.c. water daily. There were 5 pots with two plants each, for each of the treatments.

The growth and development of the plant was followed by taking the following readings at the different stages of development:—the date of germi-

nation, date of the shedding of the cotyledonary leaves, emergence of the first leaf ; the increase in height, number of nodes and number of leaves (noted every 48 hours from 1-4-45 till 19-5-45 when the leaves were becoming dry and being shed no further growth was noticed) ; the date of the first visible flower bud, of the opening of the first flower, of setting of the first fruit ; and at the end the length of the tap root, the number of branches of the root, the number of nodules on the main and branch roots, the number of branches of the shoot, the number of fruits per plant, length of the pods, the number of seeds per fruit and the weight of each seed. The mean average data for the readings of all the plants are tabulated below : —

Table I

	Date of germination	Date of shedding of the cotyledonary leaves in days	Date of emergence of the first leaf in days*
Set I	31-3-45 (5 days)	42·1	22
Set II	30-3-45 (4 days)	29·3	12

* It was found that the date of emergence of the first leaf and the date of shedding of the cotyledonary leaves were related to each other.

Table II

	Increase in height every 48 hrs. in cm.			Number of Nodes up to 19-5-45	Number of Leaves up to 19-5-45
	Early stage 1-4-45 to 15-4-45	Middle stage from 17-4-45 to 1-5-45	Late stage from 3-5-45 to 19-5-45		
Set I	0·272	0·225	0·280	6·37	5·5
Set II	0·254	0·501	1·820	12·00	17·1

Table III

	First flower bud initiation in days	First opening of flower in days	Setting of first fruit in days	Number of fruits per plant	Length of the pod
Set I	46	56·3	59·0	4·2	3·05 cm.
Set II	36	39·4	42·1	18·8	4·80 cm.

	Number of seeds per fruit	Weight of one seed
Set I	4·0	0·030 gms.
Set II	6·16	0·035 gms.

Table IV

	Length of the tap root in cm.	Number of branches of the main root	Number of Nodules on the main root*	Number of Nodules on the branch roots*	Number of branches of the shoot
Set I	11·74	4·8	2·4	6·4	Nil
Set II	12·68	10·2	8·0	19·6	4·5

* The size of the individual nodules were distinctly larger in Set II.

It is seen that the rate of increase in height every 42 hours is slightly higher in Set I in the early stage, but in the other stages it is higher in Set II and the difference is very marked in the late stage. The flowering and fruiting is hastened and the yield is distinctly greater in Set II. On the whole it was found that all the developmental changes followed were much more pronounced in Set II in which each pot received 500 c.c. water daily.

My thanks are due to Prof. J. C. Sen Gupta for his interest in the investigation.

DHRUBO KUMAR MUKHERJI

Botanical Laboratory,
Presidency College,
Calcutta, 14-10-1945.



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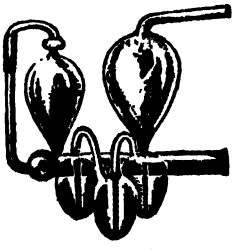
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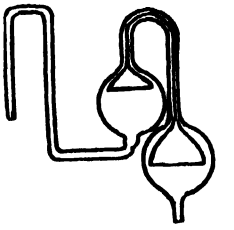
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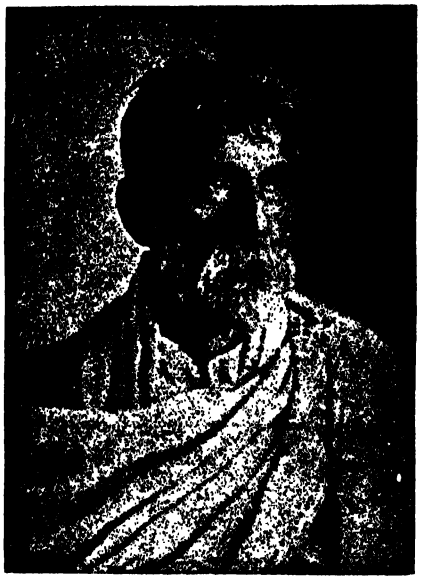
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A Monthly Journal of Natural and Cultural Sciences

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HUNDRED YEARS OF THE GEOLOGICAL SURVEY OF INDIA

THE Geological Survey of India completes in 1945 just a hundred year of its existence.* The story of its formation, and activities during these hundred years is told in detail in a subsequent article by Mr A. K. Ghosh. The Government of India have just issued a pamphlet, recommending measures for the expansion and reorganization of the Geological Survey, in view of the great demand which exists in the country for the services of a far larger number of geologists and mineralogists, if the intended industrial developments, and other constructive works that have been proposed are really to be tackled earnestly. A summary of these recommendations is given in the second article of the series.

A perusal of these articles will show that during the hundred years of its existence, the officers of the Geological Survey, have done quite a lot of creditable scientific work by their surveys. Due to their labours, the geological structure of the various parts of the Indian continent have been known in a general way, and coal fields, iron and manganese deposits, deposits of chromite, magnesite mica, sulphur and other economic minerals have been located and to some extent surveyed. The accounts of all these works are contained in the various publications of the Geological Survey, and are available to public in this country as well as in other countries.

But complaint has justly been made that the work accomplished is quite inadequate, and is only a microscopic part of the work lying ahead of us. To take a single illustration, only 189,400 sq. miles of the country (12% of the total area) have been mapped on the standard scale of one inch to one mile, while the remaining 88% of the area remains to be completed. No blame attaches to the officers of the Geological Survey of India for the failure to carry out the complete survey, for the department has been, from the very beginning, insufficiently staffed. The recent proposal of the Government of India to extend the personnel of geologists from the present strength of 30 to 130 in course of five years, though quite modest and insufficient for the needs of the country, will be very greatly welcomed, as a first step.

But 'shortage of trained geologists' is not the only drawback from which the geological organization in this country suffer. Geology is an integrated three dimensional science, and if the country wants to have a sufficiently full geological knowledge of the country, investigations should not be confined to 'surface examination of the geological specimens alone' as has hitherto been done, but should be extended to the interior, with the aid of all appliances and theories which other fundamental sciences like Physics, Chemistry, Biology, and Astronomy are placing everyday at our disposal. *We have no organization now for mobilizing knowledge of fundamental sciences in the service of the Geology of this country.*

Let us try to make the remark a little more lucid by an example. In most parts of Canada, the ground is permanently under a thick ice cover, and ordinary geological methods of investigation completely fail. Canada has therefore developed in co-operation with her Universities, geophysical methods for the exploration of mineral deposits. She employs magnetic surveys, artificial seismic methods, and gravity surveys for the location of important ore-bodies. In this way, very important ore bodies, amongst them a very

* The first man to serve as Geologist in India was Dr Voysey, who, in 1818, was attached to the surveying party of Col. Lambton as Surgeon and Geologist. He wrote a pamphlet 'On the Diamond Mines of South India'. In 1845, D. H. Williams of the Geological Survey of Great Britain was sent out as Geological Surveyor to the East India Company. For details see p. 331.

important and extensive iron ore-deposit has been discovered in perpetually ice-bound Labrador. In Arabia, where one sees nothing but a sea of sand on the surface, a group of American oil prospectors applying modern geophysical methods have found the richest deposit of petroleum in the world, which is expected to yield 84,000 million dollars (equal to 42 years budget of India) worth of petroleum. These instances can be multiplied, but we propose to take up this matter in another issue of SCIENCE AND CULTURE.

The complaint has justly been made against the Government that though, by the establishment of the Geological Survey of India, they are accummulating a good deal of valuable geological and mineral knowledge, and *making it available to the whole world,* the Government have done little or almost nothing, to utilize this knowledge in the interest of the country's industrial development. It is left to the private companies or individuals to exploit this knowledge. Further in spite of protests by eminent geologists, many of them officials like Sir Lewis Fermor, it has done very little to prevent misuse of the valuable coal and mineral deposits, which are national assets, by these private concerns, who are actuated only by a profit motive.

This question has been hanging since 1902, in which year, as mentioned in Mr Ghosh's article (third article of the series), the Geological Survey of India possessed six specialized mineral experts and was prepared for a big utilization drive. The Government of India turned down the proposal as the Government took the view that the department was mainly concerned in getting minerals for export to other countries, and diverted the staff to the newly started department of mines, whose duties consisted merely in policemen's work. Later, the Islington Commission on public services in 1915 recommended ultimate development of mineral resources by private parties.

Owing to the absence of any active mineral policy of the Government, valuable economic minerals like manganese, chromite were being shipped from India in large quantities for quite negligible sums. The utilization branch of the Geological Survey of India which was started in 1942, after the fall of Burma, has been retrenched due to some mysterious reasons.

The utilization of mineral wealth of every country depends to a large extent on industrial research. But in India there is far greater need for such research. Much of the mineral wealth of India is in a form not amenable to treatment by standard European processes and the maximum production from recognized mineral areas needs investigation. The Indian scientists, the Government and the Industrialists should co-operate for research in these problems. India produces 80 per cent of the world's better class mica, vital to the electrical industry and its future is dependent on the continuous research both in the field and in the laboratory.

NATIONAL MINERAL POLICY

The Geological Survey of India is at present in charge of the Labour Member of the Government of India but coal an important mineral has been transferred to the care of the Supply Member. The Planning Member has to plan all post-war reconstruction programmes. It is imperative that the Planning of the Geological Survey of India should be coordinated and a unified programme adopted and in this it is for the Indians to plan the programme of the future of the G.S.I. The policy of the G.S.I. has been so far to control the mineral policy and development of India's mineral resources by private parties. Even after a century of the establishment of the G.S.I., Dr Ambedkar, the Labour Member, said early last year "I shall be very candid and say that the Government of India so far had really no mineral policy".

In his statement of the Government's Industrial Policy, Sir Ardeshir Dalal, Member for Planning says, "The survey of mineral resources is another field where the responsibility falls squarely on the Central Government. Steps are being taken to extend the Geological Survey". There is a specific reference to coal only in the statement.

In the opinion of Sir Cyril Fox (1942), India even from pre-historic days—2000 B.C.—was a manufacturing country in respect of important metals and was actually exporting manufactured steel to other parts of the world. With British connection, the whole picture turned, when the only importance of the geological work on the part of the Government was realized in the interests of getting coal for the purpose of supplying ships which came from Europe with merchandize to this country. Sir Cyril Fox further said "The work of geologists in India was mainly to promote the export of raw materials rather than encourage industrial development of the country".

On March 1945, Dr Ambedkar for the first time in a statement, clarified the Government of India's mineral policy. He divided this policy in two parts: first of these was reconstitution of the G.S.I., in order to make it a more potent instrument for the furtherance of Government's policy and secondly, the Government's proposal to initiate legislation for establishing control over minerals.

In a review of the mineral resources and industries of India and their post-war development

drawn by the Advisory Committee of the Mining, Geological and Metallurgical Institute of India it is stated "there is much to appreciate in the contention that the world's industry has gained more from the use of Indian minerals than Indian trade itself has gained ; indeed the argument has been advanced by some that most of these minerals have been exported in the raw state to the detriment of India's industrial possibilities".

It is obvious that the mineral policy of the Government of India has been kept separate from the industrial policy but "the mineral policy of any Government is necessarily dependent upon the industrial policy of that Government. Minerals necessarily play a great part in the industrial development of the country and if the country has no industrial policy, obviously there cannot be a mineral policy at all", says Dr Ambedkar.

But in spite of this, in the statement of Government of India's industrial policy, the mineral policy is still left undefined.

Mr D. N. Wadia, Mineral Adviser to the Department of Planning and Development, Government of India, as Chairman of the Mining and Metallurgy section of the National Planning Committee, suggested that in planning the National Mineral Policy, it is imperative to aim at :

(1) control of unrestricted export of all the key minerals in raw stage;

(2) stoppage of export of metallic ores without a compensatory return or barter of equally important minerals and metals in which the country is deficient;

(3) a better adjustment of mineral tariff in the levying of export and import duties and fixing of quotas;

(4) domestic treatment or part manufacture of several raw materials before export;

(5) provision of facilities for free technical advice and information on mining methods and practice for minerals which are produced for home manufacturers.

Nationalization of Coal Industry

In his presidential address to the Geology and Geography section of the 32nd Indian Science Congress, held at Nagpur in January last, Mr N. N. Chatterjee specially discussed the subject of nationalization of coal. He said "if this idea of nationalization could mature successfully I think there would be maximum conservation both in extraction as well as in proper utilization". Nationalization of mines and ownership of mineral properties by the State would be ideal if practicable.

Since then Sir Ramaswami Mudaliar, Supply Member declared recently in Calcutta that the Government of India is now contemplating an enquiry into some aspects of the coal trade. The object of the enquiry would be to ensure that a national asset like coal was conserved and the interests of the industry safeguarded. The 'Indian Coalfields Committee' is now set up with Mr K. C. Mahindra until lately head of the Indian Supply Mission, Washington as Chairman, to report on the various problems of coal industry.

It is to be noted that the Government of India during the last 25 years, appointed 3 committees to report on certain well-defined problems affecting the coal industry in this country, whose recommendations have not been hitherto implemented.

The first of these considered and reported in 1920 (Foley Committee), the recommendations of R. J. Treharne Rees (1919) on the methods of coal mining in India, with a view to avoid waste of coal deposits. The second (Noyce Committee) which reported in 1925, had the limited objective of proposing measures necessary for grading of coal and stimulating the export of graded coal from Calcutta to Indian and foreign ports. The third (Burrows Committee) of 1937 reported on measures deemed necessary both for the prevention of avoidable waste of coal deposits and for securing the safety of those employed in the extraction of coal.

The Government now realizes the need for vigorous action in respect of both conservation and rationalization, if the coal industry is to play its full part in the economic re-planning of the country.

The Mahindra Committee will report in particular on the conservation of high-grade metallurgical and steam coal, the opening of new fields, the economics of the coal industry and the stabilization of coal prices.

Similarly a committee has been set up to examine the conditions prevailing in the mica trade and industry for ensuring conservation and development of this important mineral in an economic manner.

The Government of India should now clearly chalk out suitable Mineral and Industry policy immediately to safeguard the economic mineral deposits of the country and foster the establishment of industries, that would help to raise the standard of living of the masses.

Development of these mineral resources could be entrusted to private enterprise under Government control. The aim in exploitation must be to turn out the processed product as far as possible, and to establish a number of well-equipped research institutes throughout the country with strong Government backing, who should strike out new grounds by constantly investigating new processes. India has the world's largest iron ore deposits both quantitatively and qualitatively but her coking coal resources are

limited and unless immediate steps are taken to conserve coking coal, India may have none left after forty-five years according to Sir Cyril Fox.

For successful functioning in the schemes of improvement in the coal and other economic minerals, India should have a *National Mineral Policy* and that there should be a central organization like the *National Research Council* for advice and guidance.

POST-WAR PLANS FOR THE GEOLOGICAL SURVEY *

DETAILS are now available of the Government of India's scheme for the next 5 years to expand the Geological Survey of India to help extensive exploration of the country's mineral, and water resources, and thus assist post-war plans for industrial and economic development briefly reported earlier (see SCIENCE AND CULTURE, November, 1945, p. 249).

Under the scheme, the functions of the Geological Survey of India will cover (*a*) preparation of geological maps, (*b*) economic geology, (*c*) engineering geology and water supply, (*d*) geophysical work, (*e*) earthquakes, (*f*) dissemination of information, and (*g*) other functions of the geological survey.

Preparation of Geological Maps: In earlier years of the survey geological maps were prepared on the small scale of *one inch to four miles* (italics ours), and during the last 40 to 50 years, mapping is being done on the standard scale of one inch to one mile which permits the delineation of greater detail. Uptodate, approximately 1,89,400 sq. miles of the area (12%) have been mapped on the standard scale and 13,58,279 sq. miles (88%) remains to be done. Of this area 4,40,000 sq. miles consists of alluvium, for which special geological methods are required, leaving 9,20,000 sq. miles to be mapped by normal geological methods.

On an average, an area of 300 to 350 sq. miles can be mapped by a geologist in one field season of six months, and thus the services of over 200 geologists, working continuously for 15 years is required to produce a complete geological map of India. As the country is opened up, and economically important areas extend, greater detail on larger scale maps will be required as is being done with the coal-fields and mica belts of India. The importance of aerial photography is also emphasized.

As an immediate step, additional staff of geologists has been sanctioned, bringing the cadre strength to 96. The extra staff will include 70 experts—7 superintending geologists, 18 ordinary geologists and 45 assistant geologists. In pre-war days, the cadre hardly exceeded 30. The expansion will involve an increase in expenditure on geological surveying to about Rs. 25 lakhs in five years.

The present annual expenditure on geological survey is about Rs. 6 lakhs. As a contrast to this, it is reported that Russia spent Rs. 50 crores on geological survey in 1936 and employed over 5,000 geologists for the purpose.† Britain, a very small and a geologically well-explored area, spent Rs. 9 lakhs a year before the war, where the activities of the State-employed geologists were supplemented by much valuable work carried out by the universities and mining companies.

Unfortunately, in the proposed reorganization of the G.S.I., there is no mention of co-operating either with the universities or mining companies. The universities in India, working under many handicaps, have carried out considerable geological field work in recent years and we would like to point out that a closer co-operation of the G. S. I. and the non-official academic bodies will considerably help the progress of field work in Geology. In France, the '*Service de Carte Geologique de France*' is an organization for making geological maps of France and her colonies. This organization has got only a director and few paid officials on its staff. The mapping work is actually done by the help of different regional universities situated in different parts of France and each University Professor known as 'Collaborateur Principal' is entrusted with the survey of a particular area, under whom all his assistants and research students work. They are known as 'Collaborateur Auxiliare' and their mapping work is scrutinized by the Professor-in-Charge, who when satisfied with their work after field checking of their results submit them to the Director, Geological Survey.

Economic Geology: Minerals when they are of economic importance, needs prospecting, operation or even development. Recognized mineral areas, *e.g.*, coal-fields, mica belts, iron-ore areas, manganese areas, and the Singhbhum copper belts needs constant geological inspection, if these are to be conserved and maximum production obtained. During the history of the Bihar mica belt for nearly 70

* Summary of "Functions and Organisation—The Geological Survey of India".

† Prof. M. N. Saha was told that the number of geologists employed by U. S. S. R. has now increased to 10,000 by 1945. Besides in the Government Geological Survey in U. S. S. R., they have developed a number of fundamental research institutes in different parts of Russia, where geological problems are attacked with the aid of modern knowledge of physics, chemistry, biology and other developmental science, *e.g.*, (1) Institute of Geological Sciences, for the survey of mineral resources of U. S. S. R. (2) The Karpinsky Geological Museum—reorganized in 1937. (3) Institute of Theoretical Geophysics. (4) The Obruchev Institute of Eternal Frost—reorganized in 1936. (5) Institute of Geography—founded in 1918. (6) The Dokuchayev Institute of Soil Science—founded in 1925. (7) Laboratory for Hydro-geological problems—founded in 1944. (8) The Oceanographical Laboratory—founded in 1941. (9) The Volcanological Station at Kamchhatka—founded in 1944. (10) The Lake Laboratory at Leningrad with station at Lake Baikal—founded in 1928.

years, the G. S. I. has not until recently been in the position to carry out detailed work. Future of the mica belt and of other economic areas mentioned above depend upon a complete knowledge of the structure, formation and localization of the deposits. Such knowledge can be acquired only after years of work. This section will be staffed with specialists in certain minerals, *e.g.*, coal, mica, manganese, clay, gypsum, etc.

Liaision between the G S. I. and the Fuel Research Station (Dhanbad) for the study of Indian coal, between the G. S. I. and the oil companies on petrological and paleontological problems of oil geology is emphasized.

Engineering Geology and Water Supply: This involves (*a*) advice on dam-sites and reservoirs, tunnels, bridges, and other foundations, landslips, building stones, and road metal, (*b*) underground water-supply, (*c*) the study of soil and soil erosion, and (*d*) the study of glaciers.

These have to be studied in liaision with the Departments of Agriculture, Forest, Irrigation and other Public Works Department.

This section is likely to render useful service in the large post-war dam-constructions, projected in various parts of India. It is also proposed to study soil and soil erosion. This is a problem over which, India cannot sleep over any longer. But in the report there is no provision for soil survey. This is a subject that can be most conveniently and economically tackled by the G.S.I. In China, soil survey is linked with the Geological Survey of China.

Geophysical Work: This method has three main applications: (*a*) in the investigation of mineral deposits, (*b*) in water supply and engineering geology investigations and (*c*) in normal geological mapping.

Such work is now being undertaken in Britain, Australia, Canada, the African Colonies, U.S.A. and other countries on a scale undreamt of in this country.* The Survey of India (War Survey Research Institute) has done a little work of this nature on mica and manganese. Several oil companies in recent years, have devoted attention to geophysical methods for oil in India. In a paper on "Geophysical Prospecting for Oil in India", submitted to the symposium held at Delhi in November, 1945, under the auspices of the National Institute of Sciences of India, Rankine and Evans described the Geophysical work done by the B.O.C. just before the war. They carried out geophysical observations for two years at more than 22,000 stations, and surveyed 330,000 sq. miles; the total cost was 45 lakhs of rupees and the personnel numbered 90.

The Government report has merely mentioned geophysical work, but has neither emphasized its importance, nor made any specific recommendations about it. And it is futile to expect that any useful work can be done by a solitary foreign geophysicist, however qualified he or they may be.

* The Gulf Research and Development Company's budget on research alone amounts to 5 million dollars. They spend yearly about 50 to 60 million dollars on geophysical exploration.

If the Government really desires that some useful geophysical prospecting for oil and minerals be done in this country, they should take early steps for founding schools of geophysics in this country where teams of students will be trained in the handling of modern geophysical apparatus like Gravimeters, in magnetic and electric prospecting, in seismic surveys etc. as has been done on a very extensive scale in the Canadian Universities. The matter will be more extensively discussed in a future issue of SCIENCE AND CULTURE.

Earthquakes.—Field studies of earthquake effects is a part of the work of the geologist as it enables him to study the relation between earthquakes and crustal structure, but such reports, though valuable, are of the nature of postmortem examinations. Seismic institutes should be established in various centres of India, for the exclusive study of earthquakes, and possible evolution of methods of forecasts of earthquakes, and particularly for evolution of new types of buildings designed to stand severe earthquake shocks.

Dissemination of Information: Particulars concerning the mineral industry is dealt with in daily correspondence and in the Department's publications. Collection of statistics is now a recognized feature of the survey and is likely to expand. The advice of the Survey will be made available to Provincial Governments, Indian States, commercial bodies and the public.

Other Functions of the G. S. I.: The field activities of the G. S. I. as mentioned above (*a*) to (*j*) can be adequately completed, if suitable laboratories, a scientific library, a museum, a drawing office, etc., are available. The present facilities for chemical, minerological, petrological and paleontological work in the laboratories of the G. S. I. will have to be expanded considerably and modernized, consistent with expanded field activities.

The Department is thus being expanded from its pre-war cadre of 20 to 30 geological officers to a cadre of approximately 130 officers with mining and geophysical specialists and adequate chemical staff. The contemplated cadre is expected to be reached by 1950.

The scientific staff at the headquarters will consist of 1 director, 3 deputy directors, 1 petrologist and curator, 3 assistant petrologists, 1 paleontologist, 2 assistant paleontologists, 1 senior chemist, and 9 chemists.

The 3 deputy directors will be in charge of 3 sections *viz.*, administration, mapping and development. The petrologist and the chemist with assistants will be available not only to all sections of the Department but also to the general public, Universities and other institutions. The paleontologists' staff will deal with vertebrate, invertebrate fossils, paleobotany and the newly developed technique of micropaleontology.

In his evidence before the Islington Commission (1915) Mr P. N. Datta remarked, 'Every geologist was a chemist, paleontologist and petrologist, but now that all the branches had become specialized it was necessary to have a whole time officer for the work of the paleontologist alone. His work in connection with the identification of fossils was very important, if the department was to remain a Geological Survey'.

In its earlier days, the G.S.I. had on its staff eminent palaeobotanist and palaeontologists, who laid the foundation of Indian Geology. Unfortunately, the study of fossils is now utterly neglected by the survey and the Department had no whole-time palaeontologist or palaeobotanist (worth the name) in recent years. The Universities in India, are best suited for palaeontological and micropalaeontological investigations and with adequate facilities they could co-operate with the Survey for such studies. In our opinion, the increase of palaeontological staff to 3 members only will hardly cover all aspects of palaeontological investigations, consistent with the recent advancement of the science and its importance in the problems of Stratigraphical Geology.

At the end of 1948, there will be six mapping circles (instead of 4 at present) grouped as follows :—

(1) North-eastern circle—Assam and Bengal.
(2) Eastern Circle—Bihar, Orissa, Eastern States Agency.
(3) Southern Circle—Madras, Madras State.
(4) Western Circle—Bombay, Rajputana, W. Indian States, and Sind.
(5) Central Circle—Central Provinces, Central India and U. P.
(6) Northern Circle—Punjab, Baluchistan, N. W. F. P., Punjab States.

Each mapping circle will consist of :—1 superintending geologist, 3 geologists and 12 assistant geologists.

The mineral development circle and the engineering geology circle will each consist of :—1 superintending geologist, 4 geologists and 8 assistant geologists. The former will include specialists in certain minerals such as coal, mica, manganese, clays, gypsum, etc., and will be of an all-India character and the latter of men with highly specialized knowledge in the investigation of dam site, water supply and other problems pertaining to engineering.

The development division shall also include geophysicists and mining engineering staff.

For the next few years, it may be difficult to put any officers of the survey on deputation to the States or private concerns but when the officers are given on loan, charges will be levied by the Government.

The sections of statistics and information will be expanded as necessary and a journal on mineral matters in India (more popular) will be issued at regular intervals.

Indianization of the G.S.I.

The Islington Commission recommended in 1915 *interalia* :

(1) that recruitment should be made in Europe only if the Government of India are satisfied, after advertisement that no fit statutory native of India can be found in India ;

(2) a school of geology should be developed in India, which will rank with similar institution in Great Britain. This should be staffed from the department and its students should work in the field with the departmental survey parties ;

(3) opportunities for promotion should be given to qualified sub-assistants ;

(4) When recruiting from England, the vacancies should be advertised and a selection committee formed of 5 members including one Indian.

Full effect has not yet been given to these specific recommendations. The post of the Director, G.S.I. when vacant is never advertized in this country. The seniormost man in the Department if he happens to be a European is usually promoted to this post. In Great Britain, it is customary to advertize and to get the best man to fill the post of the Director. After the retirement of Sir John Fleet, who was Director, Geological Survey of Great Britain for a long time, Prof. Bailey of Glasgow University, the best man in Great Britain was chosen for this high and specialized position.

The principle of Indianization of the survey first enunciated by the Islington Commission was later revived by the late Sir B. N. Mitra, Member for Industries and Labour after the last war. When other sister departments, for example, the Meteorological Survey, the Education Service, the Agricul tural Service, were completely Indianized, the Geological Survey continued unreformed up to 1925. The reasoning was: why are not Indians employed in larger numbers in the Geological Survey? Answer: the Indian Universities do not turn out students of geology in sufficient numbers and of sufficient capacity. Why do not the Indian Universities turn out such students in sufficient number? Because there were no employments before them before the last war. In fact, the story of geological education in this country is a very sad one. The supersession of Messrs P. N. Bose and P. N Datta had such a bad moral effect that it led to a setback of geological education in this country, and it is only in recent years that educational facilities have become available in Mysore, Benares, Dhanbad and Lucknow, in addition to the facilities available in Calcutta, Madras, and Bombay since 1895. Recently, there are proposals to commence geological teaching in Patna and Nagpur, due to the munificence of the Tatas. The Government of India, the Geological Survey of India and the University authorities have paid little attention to this subject. We draw the attention of the Government and the Universities to the serious neglect of geological studies in India. In spite of these short comings, several brilliant Indian students who were trained both in India and abroad received very little encouragement from the Geological Survey of India. The ultimate aim of the Geological Survey of India should be complete Indianization and recognition of the work of Indian geologists.

A. K. G.

A SHORT HISTORY OF THE GEOLOGICAL SURVEY OF INDIA*

A. K. GHOSH,
CALCUTTA UNIVERSITY

THE history of the Geological Survey of India is linked up with the modern coal mining industry. During the Governor-Generalship of Warren Hastings, Messrs. Sumner and Heatley (1774) obtained the first permission to carry out coal mining at a place near Sitarampur. At that time coal used to be sent by boats from Raniganj to Amta and thence to Calcutta. From 1845, coal began to be transported by rail from Raniganj. The Jharia coal field was leased in 1858.

The demand for coal grew up as railways and steamships began to be introduced in India, and anticipating this demand, a Coal Committee was formed by Lord Auckland in 1836, which recommended in 1845 for 'a Geological Survey of the Coal Formation of India', to the Court of Directors in London, with the approval of the Bengal Government.

Mr D. H. Williams of the Geological Survey of Great Britain was sent out to India immediately as Geological Surveyor to the Hon'ble East India Company.

Mr Williams with the help of two assistants examined the Raniganj coal-field, and extended his survey to the Ramgarh field in 1847, Karanpura coal-field in 1848 and thus laid the foundation for a Geological Survey of India.

He was succeeded by Dr Thomas Oldham, Director, Geological Survey of Ireland, in 1851, who was designated Superintendent, Geological Survey of India. Oldham recruited H. B. Medlicott in 1854, and Blanford brothers in 1855. The office of the survey upto this time was housed in the rooms of the Asiatic Society of Bengal (1, Park Street, Calcutta). In 1856, No. 1, Hastings Street, Calcutta, was rented to locate the office of the Survey and a Museum of Economic Geology. Oldham, with true Gaelic clannishness, converted the Survey into a colony of Irish men, with a total strength of 12 officers. But in spite of such tendencies, Oldham was sympathetic to the Indian aspirations. He had introduced the system of training Indian assistants and expressed the opinion that with fair opportunities many Indians would be found quite competent to take their place side by side with European assistants, not only in the Geological Survey but also in many other fields.

Between 1857 to 1876, several eminent geologists joined the Department, *e.g.*, W. King, R. B. Foote, F. R. Mallet, A. B. Wynne, F. Stolickza, V. Ball, A. Waagen, R. Lydekker and O. Feistmantel, the paleontologist.

Dr Oldham retired in 1876, after 25 years service, when the Department had 15 geologists. He had created the posts of mining specialist, paleontologist, artist, assistant curator, librarian, etc., and obtained permission to allow officers to accompany military expeditions as naturalists. It was largely due to his energy and ability that the Indian Museum in Chowringhee was erected and thrown open to the public in January 1877. The amount of information collected during his tenure was later compiled and produced as the official 'Manual of the Geology of India', in four volumes, written by Medlicott, Blanford, Ball and Mallet.

Mr H. B. Medlicott, F.R.S., succeeded Oldham as Superintendent in 1876. New recruits included L. Griesbach, R. D. Oldham (Dr Oldham's son), P. N. Bose (1880), La Touche, C. S Middlemiss, F. Noetling, the paleontologist. In 1885, the designation of Superintendent was changed to that of Director, Geological Survey of India, and grades for Superintendents, Deputy Superintendents and Assistant Superintendents, adopted in place of first, second, and third grade assistants. Medlicott retired in 1887 after 33 years of service.

Medlicott was succeeded by Dr William King in 1887 and the latter retired in 1894 (at the age of 60) after completing 37 years of service in the Geological Survey. He discovered the Singareni Coal-field which has brought considerable revenue to the Nizam of Hyderabad. In 1893, R. D. Oldham published the second edition of the 'Manual of Geology of India' what remained a standard work on Indian Geology, for a long time. During King's time, P. N. Datta (1888) and T. H. Holland (1890) joined the Department.

Mr C. L. Griesbach succeeded Dr King in 1894, when there were 12 geological officers in the Department. New recruits during his tenure included H. H. Hayden, E. W. Vredenburg, L. L. Fermor and G. H. Pilgrim.

To sum up, the Geological Survey was established in 1845, was put on a sound footing in 1856, reorganized in 1885 and had made initial surveys of the important minerals before 1902. In the latter year the Department possessed 6 specialized mineral experts, *e.g.*, Maclaren for oil, Freyer for gold, Simpson for coal, etc., and was prepared for a big utilization drive. The Government of India, at that time, however, did not agree to this utilization work

* Compiled chiefly from C. S. Fox's Presidential Address to the Annual Meeting of the Mining and Geological Institute of India on 3rd January, 1936.

and stripped the Department of its personnel by turning the experts into simple mining inspectors. The Department of Mines being established in the same year.

At this time, the only place where Geology was seriously taught was in Calcutta, due to the efforts of Sir Thomas Holland.

Sir Thomas Holland (then T. H. Holland) succeeded Griesbach as Director in 1903 at the early age of 35. He superseded P. N. Bose who joined eight years earlier and P. N. Datta who had joined two years earlier. The number of officers at that time was 14, including 2 Indian sub-assistants. New recruits included G. H. Tipper, H. Walker, E. H. Pascoe, G. de P. Cotter, J. Coggin Brown, A. M. Heron, W. A. K. Christie (chemist), and N. D. Daru. The number of officers in 1910 was 20 including 1 Director, 3 Superintendents and 15 Assistant Superintendents and 1 Chemist on the gazetted list. Thomas Holland retired early in 1910 and was succeeded by H. H. Hayden.

Mr P. N. Bose felt the injustice of supersession so strongly that he retired form the Geological Survey the same year (1903). In a way this led to great and unexpected happenings. He was engaged by the enlightened Maharajah of Mayurbhanj as State-geologist, and in course of his geological expeditions, surveyed more critically the Garumahisani iron deposits (Hematite Ores) in the jungles of Mayurbhanj, which were previously discovered by him. He now found the deposits to be the richest in the world. At that time Mr J. N. Tata was negotiating for the establishment of iron and steel industry in the C. P. ; it is said that Mr. P. N. Bose met Tata accidentally in a railway train, while travelling together, and could convince the latter that the present Jamshedpur site was far better for such an industry. The rest of the story is well known. Thus in a way, Mr Bose's supersession proved a boon to the country for had he continued for a few years in the Geological Survey of India, his knowledge could not have been made available to the Tatas.

Both the Indian officers who were superseded in their claims on directorship were men with the highest academic record, and had achieved great reputation in their lines by their solid work in C.P., Burma and elsewhere. They naturally resented the injustice done to them, and gave vent to their feelings before the Islington Commission on public services in 1914.

To P. N. Datta, India owes a deep debt of gratitude for the discovery of many important manganese ore deposits in the Bhandara and Chhindwara districts in the Central Provinces, as early as 1893-94. But his discoveries were never made public by the departmental authorities till Sir Lewis Fermor (then Dr Fermor) with a true scientific spirit acknowledged the valuable discoveries of Datta in the field of scientific exploration. Dr Fermor writes "The fact of the existence of manganese ores in this district (Chhindwara) seems to have been first noticed by Mr P. N. Datta of the Geological Survey of India, who, while mapping the valley of Kanhan river in the cold season of 1893-94 discovered the deposit of Kachi-Dhana, the most valuable in the district and noticed fragments of one on the ground ¾th mile South-west of Khairi on the Kelod-Sausar Road . . . Nothing more was heard of these deposits till the late Mr A. M. Gow Smith, when prospecting in the year 1902, rediscovered both the above."

But for this statement of Fermor the discoveries of Mr Datta would have possibly remained in the oblivion. In his evidence before the Islington Commission Mr Datta has quoted Holland about the ability of P. N. Bose "Mr Bose retired on 1st December, 1903, after service of over 23 years and had the satisfaction of knowing that in his last year's work, he has put the country in possession of a piece of property which, without counting his other services, is sufficient to balance the total expense to Government". In the words of Mr Datta it can be said that such a testimony from such a mineral expert as Sir Thomas Holland, is a certificate indeed, in favour of Mr Bose, a certificate clearly testifying to Mr Bose's success and not a failure in the survey.

The Royal Commission on the public services in India appointed in 1912 with Lord Islington as its Chairman, in their report issued in 1915, stated: 'The object of the Geological Survey of India, conducted by a small body of 21 officers, is to make a complete geological map, preferable *on a scale of one inch to the mile* (italics ours) of the whole of India, with a view to the ultimate development of mineral resources. In th: course of that work they examine and investigate mineral deposits and do their best to bring them to the notice of the general public. In this way they are brought into touch with commercial interests, but not more than one-third of their number are allowed to be employed on investigations of this nature. The rest are kept strictly to the systematic survey of the country.

In 1919, the Cadre of the Department was increased to one Director, six Superintendents, twenty Assistant Superintendents and five Sub-Assistants. New recruits during Hayden's time included H. S. Bion, C. S. Fox, H. Crookshank, E. L. G. Clegg, D. N. Wadia, G. V. Hobson and J. A. Dunn.

Sir Henry Hayden was succeeded by Sir Edwin Pascoe in 1921. During Sir Edwin's tenure the Raniganj and Jharia coal-fields were re-surveyed geologically on the scale of 4 inches to a mile. Generally survey had so far been conducted on the scale of one

inch to four miles. New recruits included A. L. Coulson, E. R. Gee, W. D. West, M. S. Krishnan, S. K. Chatterjee, J. B. Auden, V. P. Sondhi, H. L. Chhibber, P. K. Ghosh, and M. R. Sahni.

Sir Edwin Pascoe was succeeded by Sir Lewis Fermor as Director in 1932. At this time the budget grant to the Geological Survey amounted to Rs. 6 lakhs a year and the same amount is being voted on Geological Survey even today. Sir Lewis retired in 1935 and was succeeded by Dr A. M. Heron. Sir Cyril Fox succeeded Dr Heron in 1939.

During Sir Cyril's tenure, the World War II commenced and this led to the establishment of the utilization branch of the Geological Survey of India (sponsored by Sir Cyril) at a huge cost to assist in the war efforts. A number of geologists were added to help in the exploration of several unexplored areas in search of new minerals and co-operation of the Universities was sought for mineral investigation. This became imperative after the fall of Burma. Sir Cyril retired in 1943 and was succeeded by Dr E. L. G. Clegg. The latter died in 1944, when Dr H. Crookshank succeeded him. For some mysterious reason and since the improvement of the war situation, the utilization branch is retrenched involving a huge loss of money to the Government. This department to some extent showed the way to the industrialists, the scope and importance of research in minerals, etc.

NATIONAL ACADEMY OF PEIPING AND ITS WARTIME ACTIVITIES

JOSEPH NEEDHAM

PEIPING, the historical, picturesque metropolis of North China, famed for its colossal ancient palaces, its numerous excellent universities and colleges of sound learning, its peaceful, dignified academic atmosphere, was at the time when Japan started the war in July 1937 the greatest cultural center of China, where hundreds of educators, scholars and scientists gathered to devote their entire effort to intellectual pursuits. In 1929, it was decided by the Executive Yuan of the National Government to organize in Peiping a government research institution, the National Academy of Peiping, parallel in structure to the Academia Sinica, for absorbing a portion of the personnel, in order that they could work more efficiently.

This institution was founded on the 9th September, 1929, with Dr Li Yu-Ying as President, and Dr Li Shu-Hua as vice-President, both among China's foremost scientists and educators. At its foundation, the Academy consisted of nine separate research institutes, namely the Institutes of Physics, Radium, Chemistry, Materia Medica, Physiology, Zoology, Botany, Geology, Historical Studies and Archaeology, and a staff of more than 200 members including research professors, assistant research professors, senior and junior assistants and technicians, in addition to about 30 Chinese and foreign corresponding members. Contributions in all branches of research have been published in various languages, scattered through almost all the principal scientific journals of the world.

In subsequent years, scientific work in the various institutes was going on exceedingly well, only one or two years before the outbreak of the present war, when the complex and tense political situation created in China's northern provinces by the Japanese militarists rendered further activities of the Academy extremely precarious.

To avoid too much risk, it was therefore decided to move the whole of the Institute of Botany westward to Shensi Province and the greater portion of the Institute of Historical Studies and Archaeology to the same destination ; the Institutes of Radium and Materia Medica to Shanghai and the Institute of Geology, accompanied by the Geological Survey of China, to Nanking.

When the war started in 1937, Peiping was immediately taken over by the invaders. The Academy was forced to withdraw and relinquish all its studies except for those institutes that were no longer in Peiping. In fact, at that time, all research activities were virtually stopped or at any rate, indefinitely postponed. However, in the midst of confusion and distress, the Academy succeeded in transferring a part of the books and equipment to the south and to places of safety. And what was even more fortunate, within a few months after the war had reached a state of stabilization, the Academy was able to settle down in the hinterland city of Kunming, where it has continued up to the present moment, and resume a large portion of its work.

One can imagine the danger and trouble it experienced in getting through areas of intensive military operations and lines of blockade, on the way from Peiping to Kunming, a distance of more than 2,000 miles by land and sea. Tremendous difficulty

was encountered in arranging for the transportation of material equipment.

In spite of the hardships arising from the lack of the necessary research facilities, and the frequent interferences by air raids, the work of the Academy has been pushed on vigorously to an extent beyond the most sanguine expectation. The interest and belief in science of all its staff members did not suffer.

Now, as the war has come to a happy end, and before the implementation of the post-war programme, one may pause a moment to think back over the pre-war activities of the Academy and then describe the work performed during the eight years of war in its different institutes. This may give some idea of what the scientific workers of China did in time of peace and while the nation was being overrun by a catastrophic war.

Before doing so, a few words on the present situation of the Academy as a whole, may be said.

The National Academy of Peiping has now eight institutes, with a staff of 120 members (Institute of Geology not included). The Institute of Physiology had to close temporarily in August 1944, because of deficiencies in personnel and equipment. The Institute of Geology has since its establishment operated under the joint sponsorship of the Academy and the Geological Survey of China under the Ministry of Economic Affairs. For the last eight years, the Academy has not been able to finance that institute, and besides it had great difficulty in getting in close touch with the Geological Survey of China after the latter's withdrawal to Chungking during the evacuation of Nanking in December 1937. The two institutes in Shanghai, namely the Institutes of Radium and Materia Medica, moved to Kunming shortly after the start of the war. The Institute of Historical Studies and Archaeology came to Kunming in the very early days of the war. A small portion of the Institute of Botany is now in Kunming while the other portion remains in Shensi. Hence with almost all the seven institutes and a general office located in Kunming, a closer cooperation and more centralized administration have been made possible.

In Kunming, laboratory and office work have been carried out under the roofs of temporary, crudely-built quarters at Hei-Lung-Tan, a scenic spot to the north of Kunming near a famous Taoist temple. Here are located the Institutes of Physics, Radium, Chemistry, Materia Medica and Historical Studies and Archaeology. The Institutes of Zoology and Botany maintain their work at another place to the west of Kunming.

The policy of the Academy in general in war time has been to divert the greater portion of its activities to practical ends in order to meet the immediate needs of the nation. Publications which in former years ran to nearly 50 series of bulletins, journals, memoirs, books and maps plus 800 papers and reports are still in progress, but on a very much reduced scale, owing to the lack of efficient means of printing in West China.

Institute of Physics

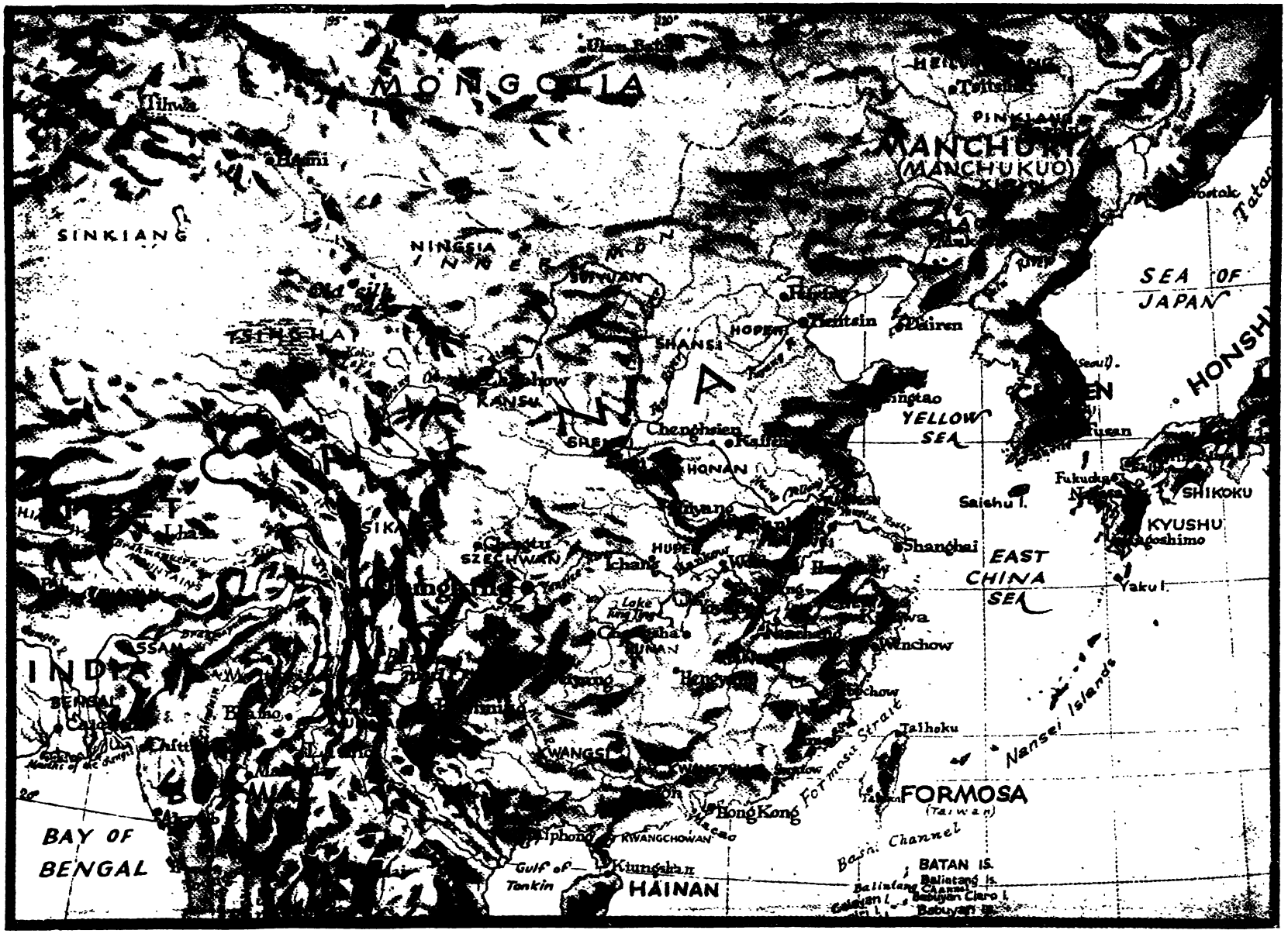
Previous to the war, the Institute of Physics, directed by Dr Ny Tsi-Ze and occupying more than half of the Physical Science Building in Peiping, was making studies chiefly on photography, spectroscopy, piezo-electricity and geophysics. Its laboratories were equipped with many types of spectrographs, electrical apparatus, gravity and magnetic field measuring instruments, machine shop, optical workshop and modern conveniences of water, electricity and gas. In those days, research work went on in a steadfast and vigorous manner.

Spectroscopic investigation, being the chief speciality, was in the charge of Dr Ny himself and a team of assistants. Problems involving the change of many varieties of spectra under different experimental conditions were subjected to exhaustive study. Effect of pressure on photographic sensitivity, piezo-electricity of quartz under rotational stress, designing and grinding of optical parts, etc. occupied also a good portion of the work of the Institute.

Geophysical work was confined to the measurement of gravity and terrestrial magnetic field made by Mr Lou Jo-Yu and Mr Chang Hung-Chi successively throughout the accessible parts of China, with the co-operation of Fathers P. Lejay and P. Burgaud, both belonging to the Zi-Ka-Wei Observatory near Shanghai. A party led by Mr Tchou Kouang-Chai was dispatched to different areas to make accurate determinations of longitudes and latitudes.

To comply with the general policy of the Academy, after its removal to Kunming in the early days of the war, the institute inclined more and more to attack practical problems connected with industry and national defence, along with pure physical researches. In view of such demands, the institute concentrated on two main branches of practical work, namely, the manufacture of optical instruments, and geophysical prospecting.

For the former, Dr Ny and Mr Tsien Ling-Chao have been in charge of the work of designing and testing while Mr Lin Yu-Pao supervised the optical workshop which is actually much bigger in scale than the one in Peiping. For this purpose, optical machinery had to be built, testing instruments designed and craftsmen trained. After three years of painstaking preparatory work, it can now produce in good quality most of the optical parts such as achromats, prisms and flats, which have been abundantly supplied to various institutions for educational and research purposes. Microscopes for general use of


MONGOLIA
Tihwa
Hami
SINKIANG
NINGSIA
SUIYUAN
SHANSI
KANSU
SHENSI
HONAN
HUPEH
Chengtu
SZECHWAN
Chungking
Ichang
Changsha
HUNAN
KWANGSI
KWANGTUNG
Hong Kong
Kiungchow
HAINAN
Gulf of Tonkin
Iphong
KWANGCHOWAN
BAY OF BENGAL
INDIA
BENGAL
Bhamo
Chittagong
Mouths of the Ganges
Tsitsihar
MANCHURIA
(MANCHUKUO)
Hsinking
Changchun
Mukden
Antung
Dairen
Yingkow
Chinchow
Tientsin
Hopeh
Tsingtao
Chenghsien
Kaifeng
Hankow
Shanghai
Wenchow
Foochow
Amoy
Swatow
Taihoku
FORMOSA
(Taiwan)
Formosa Strait
Basi Channel
BATAN IS.
Babuyan Claro I.
Babuyan Is.
Nansei Islands
Saishu I.
Fukuoka
Nagasaki
SHIKOKU
KYUSHU
Kagoshimo
Yaku I.
SEA OF JAPAN
YELLOW SEA
EAST CHINA SEA
HONSHU
Tatar Strait

university students have been made in response to a recommendation by the Ministry of Education and more than 500 of them have been completed and distributed among schools and hospitals. The microscopes thus manufactured consists of five objectives, namely ×32, ×9, ×20, ×48, and oil-immersion ×100, and are sufficiently good for all purposes, biological, medical or metallurgical, in optical quality. To many engineering projects, the institute has from time to time supplied at least 150 sets of optical parts of surveyor's levels and transits, with internal focussing arrangement and at magnification 22 and $f/10$. Upon the request of the National Resources Commission, a projector for reading microfilms was designed and 20 sets were made.

In the course of the war, numerous radio stations, both fixed and movable, were established throughout Free China, but almost all of them of quite small power. The wave interference between these stations would be troublesome if they were not crystal-controlled. The institute has cut and ground piezo-electric quartz plates to stabilize more than 1000 transmitters. The optical shop also rendered service to the American Air Force in Kunming, repairing optical parts upon their request. Moreover, a laboratory of spectrum analysis was set up to meet the need of the young metallurgical industry in this country. Some routine work was carried out and certain new techniques developed.

Not until lately has it been possible for the institute to begin to resume some of its former pure scientific work. Mr Tsien Ling-Chao has investigated the interferential fringes formed by the Hilger Prism Interferometer. A new method has been found for the determination of $1/\lambda_1 - 1/\lambda_2$ of two neighbouring radiations. He has also constructed a supersonic wave generator for the purpose of studying the depolarization effect of such waves on light in liquids in which they propagate. A mechanical recording seismograph has been designed and is now under construction by Mr Ku Kong-Gyiu to record earthquakes in Kunming. This instrument will be the first of its kind ever set up in Yunnan Province.

In geophysical work, Mr Chang Hung-Chi, a member of the institute, continued gravity determinations throughout the Province of Yunnan to the borders of Burma and Indo-China, and another member, Mr Liu Shao-Yang, re-determined the longitude and latitude of Kunming. Most of the attention of the institute's geophysicists, however, has been directed to the mineral resources of China.

A field party for geophysical prospecting led by Mr Ku Kong-Gyiu has operated for many mining organizations of Southwest China, studying mainly metallic ore deposits by magnetic and electrical methods. Up to the present some eleven mining districts have been thoroughly investigated. The N. R. C. (National Resources Commission) I-Men Iron mine was the first to be surveyed by Mr Ku and his party; it took six months of field and office work. Then came the Anning Iron deposit, the Kochiu tin mine, Lu-Dien lead-silver and pyrite deposits, the Chaotung lignite field, the Kuang-Shan-Tsan lead-zinc mine, the I-Loh pyrite deposit, the Tong-Tan and Loh-Shueh copper mines, all located in the Province of Yunnan. The latest work has been done at two localities in western Kweichow, namely the Shueh-Tseng and Hai-Tsang iron deposits. All of these were successively visited by the party upon the request of the N. R. C.

The results of such geophysical investigations have not only greatly altered the concepts of geologists and mining engineers in regard to the extent and economic values of the various deposits, but also numerous facts and experiences arising from them have opened the door to improvements in the methods of geophysical prospecting itself. The number of reports so far written (in Chinese), under the title "Geophysical Reports: Institute of Physics, National Academy of Peiping", has accumulated to twelve. In carrying out this type of work, close relation has always been maintained with the National Resources Commission and the Geological Survey of China. With the co-operation of the latter, a committee on geophysical work has been organized to publish all contributions from Chinese geophysical investigators.

Dr Ny, the institute's director, received recently an invitation from the U. S. State Department to tour the various centers of learning in the United States as a visiting professor. During his absence, probably for one year, Dr Li Shu-Hua, vice-President of the Academy, will act as director of the institute.

Institute of Radium

This institute, also directed by Dr Ny Tsi-Ze, co-operated, since its founding in 1929, with the Franco-Chinese University of Peiping. Its work involved three successive stages according to the environments under which the institute existed.

In the first stage the institute was still in Peiping. During that period, it consisted of three laboratories, that of chemistry, radio-activity and X-rays, all situated in the Physical Science Building. In the first two laboratories, a great number of minerals found in China were examined chemically and radioactively. Protactinium was much studied and its branching ratio re-determined with counters by the late Dr Tcheng Da-Tchang. In the X-ray laboratory, the work was mainly on crystal analysis and the effect of pressure on X-rays sensitivity of photographic plates by Dr Lu Shueh-Shan and his assistants.

The second stage covered the interval when the institute had been moved to Shanghai and work was carried out under war conditions. With Dr Tcheng and Dr Lu still on the staff, Dr Choong Shin-Piaw joined this institute upon his return from France in Autumn 1938.

Items of research were numerous. To mention a few of the outstanding ones, the first may be the investigations by Dr Tcheng and his assistants of the absorption coefficients of β-rays, especially from UX_2 and RaE, which revealed the important fact that they neither have a fixed value nor a single value, but depend on the thickness of the absorber and the surrounding conditions of the β-ray source under experimentation ; analysis of the β- and γ-rays from Ux ; the preparation of Ux_1 and U_2 by electrolysis and the coloration effect of β- and γ-rays on certain new kinds of glass. X-ray work by Dr Lu and others was still confined to crystal analysis, particularly on alloys, some improvements on classical methods and techniques being made. With an induction furnace alloys of tungsten and antimony were prepared and studied by X-ray methods.

Right after his joining the institute, Dr Choong began some experiments on the absorption spectra of aqueous solutions of salicylic acid and its alkaline salts, and ultra-violet absorption spectra of vaporized salicylic acid and lithium salicylate. He also did some work on the preparation of special kinds of optical glass, for example, "Uviol".

At about the close of this stage, the institute unhappily had to report the untimely death of Dr Tcheng at a still youthful age. His contributions to science, academic standing, vigour in research, together with his inspiring personality, made him a man whom the institute could not afford to lose.

The third stage came when Shanghai ceased to be suitable for scientific work on account of the Japanese occupation, and Dr Choong had to come to the interior. Dr Choong set up his laboratory in Kunming with only very limited equipment, while Dr Lu remained in Shanghai with almost all the laboratories and equipment confided to his care. For more than three years, the main body of the Academy lost all connection with Dr Lu and his working team, owing to the complete isolation of the Shanghai area from Free China.

In Kunming, under very unfavourable conditions, Dr Choong accompanied by two new assistants started to do some work suitable for the new environment. Several investigations were carried out and some of the results published. These were: (1) Influence of pneumatic pressure on photographic sensitivity (*J. Opt. Soc. America*, 1944) ; (2) Orientation of etching figures of quartz (*Nature*, 1944) ; (3) Effect of ultraviolet radiations on the etching of quartz (*Nature*, 1944) ; (4) New etching pattern of quartz and its use for the determination of electric axes and detection of crystal defects of quartz (*J. Opt. Soc. America*, 1945) ; (5) Coloration and luminescence produced by radium rays in the different varieties of quartz (*Proc. Phys. Soc. London*, 1945) ; (6) New crystal defects of quartz revealed on sputtered films of silver and gold (paper in preparation).

From the study of photographic sensitivity, it was shown that the effect of pneumatic pressure on the sensitivity of a photographic emulsion is in many respects different from that of mechanical pressure. In the quartz etching experiments, several interesting phenomena were observed ; first, the pyramidal etching figures produced by hydrofluoric acid on a section normal to the optical axis of quartz are directed to the mechanical axes instead of the electric ones as generally believed ; secondly, these pyramidal figures are notably deformed, if the surface under etching is meanwhile subjected to the action of ultraviolet radiations. When the etching takes place under an electric field, an entirely new pattern appears with which one can fix accurately the electric axes of the crystal as well as their polarities. Regarding the effect of radium rays on quartz, it was found that crystalline quartz of all varieties turns black while vitreous quartz becomes violet when exposed to those rays, and that on heating coloration and thermophosphorescence do not disappear simultaneously—a fact rather hard to explain on the basis of the theory of internal photoelectric effect. As to the experiments on the sputtered films of silver and gold on quartz plates cut normally to the optical axis, it has been disclosed that, in most cases, a system of concentric polygonal figures with sides strictly parallel to the electric axes was formed on baking the film after sputtering. There is reason to believe that the polygonal figures represent the seats of a new kind of crystal defect of quartz arising from the so-called primary crystal flaws.

Besides such pure research, Dr Choong has developed techniques of making mercury quartz lamps of the Honeau and Gallois types to meet the demands of some hospitals using ultraviolet radiations for medical purposes.

During Dr Ny's leave as visiting professor in the United States, Dr Li Shu-Hua, vice-President of the Academy, also takes his place as the institute's director.

Institute of Chemistry

In its former years, the Institute of Chemistry was housed with the Physics and Radium Institutes in the Physical Science Building in Peiping and

Dr Liou Oui-Tao was the director. Dr Liou himself took up physical chemistry. His interest was mainly the study of cobaltic salts. Messrs Li Lin-Yu and Yang Kuang-Pi and their assistants were occupied with inorganic work, relating to the methods of determination of aluminium, and the electrolytic preparation of magnesium per-sulphate. Dr Tcheau Fa-Ki made some investigations on organic magnesium compounds of acetylene and employed the Friedel-Crafts reaction in synthesizing aromatic hydrocarbons.

In the field of applied chemistry, Dr Chang Han-Liang, with the co-operation of Dr Liou and Dr Tcheau, studied a number of problems on active carbons, asphalt, gasoline, Tung oil, molasses, gelatine, dye-stuffs, etc. In 1936, the institute, with the financial aid of the Sino-British Indemnity Fund, started a chemical pilot plant, in which was installed a machine for ice-making, a pulverizer, a nitrator, a sulphonator, a centrifuge and a vacuum distillation outfit. The staff were thus able (1) to extend, when necessary, any chemical experiments performed in the laboratories to a semi-industrial scale, and (2) to prepare chemical reagents for scientific use.

The institute itself published all detailed results, while abstracts can mostly be found in the *Comptes Rendus* of the French Academy of Science and in the *Bulletin* of the French Chemical Society.

All this was going on before the outbreak of war in July 1937. In Kunming conditions were so different that this institute, like all the others, had to devote much of its effort and time to problems having practical value in addition to pure chemical research. Much time had to be spent in getting the new laboratories and equipment in order. As time went on, this institute found itself more crippled than any other, because many reagents could only be obtained from abroad and these were consumed at a rate far beyond the power of replacement under blockade conditions. By careful management, however, the institute succeeded in carrying on its work somehow during these eight years.

Before giving a brief account of the wartime work, some changes in personnel may be referred to. Mr Li Lin-Yu and Mr Yang Kuang-Pi were not able to come to West China and remained in Peiping. Dr Chang Han-Liang left the institute after being in Kunming for two years. Dr Tcheau Fa-Ki became the Dean of the Science College of the Franco-Chinese University in the early days of the war. In the course of eight years, there have been new members, notably Dr Wang Shuih and later Dr (Miss) Chu Ju-Hua, besides several new senior and junior assistants. Mr Chang Ming-Tse and Wang Tse-Fu, two research members, remained on the staff only about one year each, and then left to take up appointments as general managers of two new chemical factories. Dr Tcheau Fa-Ki very recently returned to the institute to resume his former work and now, in the absence of Dr Liou who is on furlough, he acts as director.

In the field of practical chemistry, the investigations that have gone on within the war period come under four heads; all of them have been problems calling for immediate solution. They are (1) extraction of dye-stuffs from local plants and their application to various textiles; (2) preparation and small scale manufacture of medicines, utilizing local raw materials; (3) recovery of used engine oils, replacement of Diesel oil by vegetable oil and preparation of a gasoline substitute from molasses and sawdust; (4) miscellaneous experiments such as the analysis of water samples taken from various localities around Kunming, the extraction of potash from different kinds of ashes, etc. Dr Chang Han-Liang was the first in charge of such work. He was followed by Dr Wang Shuiah, Mr Chang Ming-Tse and Mr Wang Tse-Fu. In view of the drastic shortage of gasoline in blockaded China, a mobile alcohol plant was brought into operation. Despite its simple design, it was steadily producing 200 gallons of 95% alcohol per day for more than one year. In co-operation with a soap factory, complete installation of a vacuum distillation plant was set up to produce glycerine from soap-making waste. With the ice-generator, ice has been manufactured and supplied to the Allied force in Kunming for refrigeration purposes.

In the field of pure chemical research, attention has been mainly centered on problems of organic and physical chemistry. Topics taken up in the organic laboratory have been (1) synthesis of organic compounds relating to vitamin K; (2) pinacol rearrangements of phenanthrene; (3) preparation of the angular methyl group; (4) synthesis of rotenone derivatives. These studies were made by Dr Chu Ju-Hua and Dr Wang Shuih and their assistants; most of the results have been published both in the Chinese and Western periodicals. Miss Chu left for the United States in Autumn 1943 to continue her researches at University of Texas, Austin, Texas, which had offered her a research professorship.

Recently Dr Wang Shuih has attempted to elucidate the structure of some of the organic products previously isolated from Chinese drugs. "Deutaton" ($C_{15}H_{10}O_4$), a substance isolated from To-Ta-Huang (*Rumex dcutatus* L.), was found to be a phenanthrene derivative and *l*-methyl, 6, 8 dihydroxy phenanthroquinon 9, 10 has been proposed for it. "Belmacandin" ($C_{22}H_{22}O_{11}$), a glucoside isolated from another Chinese drug, Shi-Kan (*Belmacanda Sinensis*, Lam.), was found to give on hydrolysis an aglucone "Belmacangenin" ($C_{16}H_{12}O_6$), which in turn gave

p-hydroxy-phenyl acetic acid on being treated with 10% alcoholic potash, while the phenolic dehydrating product is still under investigation.

Dr Tcheau, since his return to the institute, continues his former work on organic magnesium compounds. Problems taken up are now the carbonatization of magnesium compounds of acetoacetic esters, and the molecular transposition of phenyl-quinoline-magnesium bromide.

In the laboratory of physical chemistry, Dr Lion has been continuing his studies on cobaltamine complex salts. Examination of the system cobaltiaquopentamine-water-oxalic acid by Schreinemaker's method at different temperatures has given results somewhat different from those so far found in the literature. Definite conclusions are expected soon. Studies on the kinetics of the oxidation of potassium iodide by potassium persulphate and on the absorption of solutes by animal black from their solutions have also been going on.

Institute of Materia Medica

Research on Chinese drugs is a new branch of pharmaceutical chemistry. Dr T. Q. Chou, one of China's foremost chemists, made many outstanding contributions along this line of work during the early part of his career while he was still with the P. U. M. C. (Peiping Union Medical College). He is generally recognized as the person responsible for the opening up of this branch of scientific investigation. The Institute of Materia Medica, with Dr Chou as the director, was carrying out particularly this sort of work.

Started in Peiping and later moved to Shanghai, a great portion of the results of this laboratory has been published in a number of Chinese and American journals. Studies so far made on Chinese drugs include Chinese *Ephedra*, Mahuang ; Chinese *Corydalis*, Pei-Mu ; Hsi-Hsin ; Mu-Fang-Chi ; Shih-Chan-Chu ; Yang-Chin-Hua ; Kou-Wen ; T-Ch'a-Yeh, etc. The active principles have been isolated and their constituent properties as well as their pharmacological actions examined. The institute also prepared materials like ephedrine, vitamin B, etc. on commercial scale for clinical use.

Besides Dr Chou and his co-workers such as Dr Chu Tse-Tsing, Dr Chuang Chang-Kung, formerly director of the Institute of Chemistry of the Academia Sinica, joined the group in Shanghai. His pre-war activity and contributions in organic research on hormones have been widely known among chemists of all nationalities. Results so far attained by him have made important advances in the knowledge of hormones. Upon his arrival at Kunming in January 1944, Dr Chuang tried to start some work with the help of the Institute of Chemistry.

A new research programme in the field of thiazole and pyrimidine has been started very lately by Dr Chi Yao-Feng, formerly research fellow of the Institute of Chemistry, Academia Sinica, and professor of pharmaceutical chemistry of the National Shanghai Medical College, in charge of the work. Dr Chi came to join this institute in the latter part of 1944. This new research programme is being directed towards the synthesis of compounds of the atebrin and plasmoquin types with a thiazole ring attached to the amino-alkyl side chain, in attempts to find new antimalarials. It is hoped that the work could later be extended to the synthesis of vitamin B_1 analogues which contain both thiazole and pyrimidine rings.

Dr Chuang, now the acting director of the institute in the absence of Dr Chou, has been concerned with the preparation of a post-war programme of research in his own line on a much augmented scale. He will be leaving shortly first for the United States and then Europe to make a tour of chemical laboratories.

Like a portion of the personnel of the Institute of Radium, Dr Chou and several members of the Institute of Materia Medica have not been able to get in contact with West China since Shanghai was completely isolated nearly three years ago.

Institute of Physiology

This institute, formerly directed by Dr King Li-Pin, had to stop its research activities completely in autumn 1943. Before it moved to Kunming, there had been a programme of research involving studies in problems of experimental biology, cytology, and physiology. This programme was later slightly modified to include work on the physiological effect of various Chinese drugs. A considerable amount of material has been published both in Chinese and French periodicals.

While in Kunming, the institute made some effort to work on subjects capable of application in daily life, besides continuing pure scientific work. In this connection, investigations into the nutritive values of the foodstuffs used by the inhabitants of the Southwest, experiments on the treatment of chicken cholera by sulfanilamide, as also of typhus by some Chinese medicines from the ancient herbal, the "Pen-Tsao", are of significance. Also of local importance has been the work on the types of Chinese drugs produced in Yunnan, and the basal metabolism of the Yunnanese people.

As the war dragged on, much of the institute's activity was retarded and finally stopped. In 1943,

the Ministry of Education appointed Dr King the head of an Institute of Chinese Pharmaceutics, and the institute was then suspended.

Institute of Zoology

The Institute of Zoology was started, with Mr Lou Ting-Heng as the director in Peiping, to carry on studies on the animal life of China, and located with the Institute of Botany in the Biological Science Building. Before its move to Kunming, the institute organized many expeditions for collecting animal specimens and studying their ecological distribution. Special attention was paid to the sea-shore animals of China. Field stations were set up at coastal cities like Chefoo, Weihaiwei and Tsingtao, and parties dispatched to places like Amoy, several sea ports of Kuangtung Province and the Dutch East Indies. Land animals such as birds, reptiles of some parts of the Province of Hopei and in the vicinity of Peiping, the amphibians of Kuangtung and the East Indies were also collected and thoroughly investigated. The number of specimens had accumulated to over 10,000, while some 24 papers and reports were published. Work in experimental zoology and cytology in fishes and frogs was taken up by several members.

Upon settling down in the inland city of Kunming where only fresh water animals were available, the work of the institute had to be directed to the study of limnological fauna in Yunnan Province. Thus the fauna of the Kunming Lake, the Erh-Hai, the Yang-Tsung-Hai and the Fu-Siang Lake became the most easily attainable material. To intensify such investigations an experimental station for lacustral biological studies was started in 1930 under the joint auspices of the institute and the Bureau of Reconstruction of Yunnan. This station is the first of its kind in China and, despite its very brief history, has been able to carry out systematically a considerable amount of studies on the principal fresh water fauna of Yunnan, particularly the fishes of these inland lakes, their diseases and enemies, together with the chemical and physical properties of the lake waters.

Besides aquatic animals, terrestrial animals like reptilia and the spiders of Yunnan have also been collected and examined. Topics so far under investigation have been numerous; to illustrate their character, those recently conducted may be referred to as follows: (1) the artificial propagation of Tsing Fish (Matsya sinensis, Bleeker) from Yang-Tsung-Hai; (2) the investigation of the fishing gear of Yunnan; (3) the study of plankton, Cladocera and Copepoda of the Kunming Lake; (4) a study of the edible snail *Margaris melanioides* Nevill, of the Kunming Lake; (5) the ducks of the Kunming Lake; (6) some fresh water sponges of Yunnan; (7) some reptilia of Kunming and its vicinity; etc.

In April 1940, the institute suffered the most serious drawback in Mr Lou's sudden death from complications following an operation. Dr Tchang Si, research professor of the institute, succeeded Mr Lou as director to carry on the programme of research.

Institute of Botany

This institute occupying more than half of the Biological Science Building in Peiping has since its foundation been working mainly on the plant life of North, North-Eastern and North-Western China and its taxonomy. Investigations on agriculture and forestry, such as the distribution of forests, classification and diseases of farm plants, were also under way. Dr Liou Tchen-Ngo was and still is the director, with Drs Ling Yong and Wang Yun-Chang as the research professors. Extensive collecting of plant specimens from a great many regions was organized by the institute before the war. For this purpose Dr Liou himself, in one of the expeditions, went as far as Sinkiang and crossed the formidable Kuen-Lun Mountains to the north of Tibet. The number of specimens thus accumulated had reached more than 60,000 and over sixty publications had been made.

In 1936, under the joint sponsorship of the institute and the National Northwestern Agricultural College, a special Botanical Survey was planned and organized at Wu-Kung, in Shensi Province, to do research on the plant life of North-West China and its economic value. Shortly after this, the entire institute moved westward and both personnel and equipment were able to resume activities in the far interior Province of Shensi.

Since then, the principal items of research have been studies on higher plants, on lower plants, on drug plants, and on the geographic distribution of plants of North-West China. Materials obtained have been used in the compilation of a comprehensive volume on the plant life of North-West China. In 1940, a botanic garden was brought to completion, in which many experiments have been performed. Botanic parties were frequently sent out to the various centers of botanic interest throughout the Northwest, particularly to the great western mountain ranges. To acquire some knowledge of the flora of the South-west, Dr Liou himself came to Yunnan several years ago to carry on the work locally. He has been in the vicinity of Ta-Li and many parts of Western Yunnan. In Kunming, he was joined in 1943 by Dr Hao King-Seng, a new member of the institute, whose interest lies chiefly in forestry. The institute is now in possession of about 70,000 plant specimens, one of the largest collections of its kind in China. For the botanic garden, many new plants have been brought from different localities.

Institute of Geology

As mentioned above the programme of geological research of this institute was initially carried out cooperatively with the Geological Survey of China, under the director Dr Wong Wen-Hao, and many research professors such as Mr Hsieh Cha-Yong, Mr Huang Tsi-King, Mr C. C. Young etc. Its contribution to geological science itself and to the geological knowledge of China had already been very significant by the beginning of the war. Reports, memoirs, bulletins, journals and maps published by the Institute had a very wide circulation. The institute has existed in three distinct phases during its history. From 1930 to 1935, the first phase, the institute was still located in Peiping and everything was proceeding in full swing. Within this period a building for offices and library and another for the Fuel Research Laboratory were erected, followed by a Museum and a Cenozoic Laboratory. With the cooperation of the P. U. M. C. (Peiping Union Medical College), excavation was started in limestone caves at Chou-Kou-Tien near Peiping, resulting in the discovery of the fossil remains of the well-known *Sinanthropus pekinensis* (Peking Man) and its contemporary vertebrates. A Seismological Laboratory was meanwhile set up at Tehiu-Feng in the outskirts of Peiping to record earthquakes by modern instruments. Then a Soil Division began to make surveys of the soils of different provinces and construct soil maps.

In the office much time was devoted to palaeontological research in order to work out the stratigraphy of many parts of China. In the field, both geological mapping and mineral prospecting were intensively carried out. The Institute completed the geological maps of Hopei, Shansi, Shantung, Kiangsu, Shensi and Suiyuan Provinces by about the end of 1935. Several parties went as far as the Tsinglingshan and Chilienshan areas and to Szechwan, Sikang, Kweichow and Yunnan Provinces for regional work. In mineral prospecting, the institute paid particular attention to the coal deposits of North and Central China and to various iron mines.

The second phase came when the greater part of the institute had to move south to Nanking in 1935, while the smaller portion remaining in Peiping as a branch. While in Nanking, the institute was housed in a central building which comprised the museum and offices, and several auxiliary buildings in which were located the library, chemical and fuel research laboratories, all new and well equipped. Palaeontological and stratigraphic studies still went on in the office ; field investigations had to be restricted to provinces situated along the Yangtze Valley. Special emphasis was laid on the mineral deposits of the Nanking area, Hunan, Kiangsi and Kweichow Provinces.

Soil survey was still under way. The Seismological station continued its recording in Peiping. A new division for geophysical prospecting began to work on mineral deposits with torsion balance. The fuel laboratory put much efforts into extracting light oils from vegetable oils besides its former work on coking of coal and low temperature coal tar distillation.

The third phase began in 1937 when the war started and the institute had to withdraw westward first to Changsha and then to Beipei near Chungking. Most of the equipment was got out of Nanking during its sudden fall to the Japanese in December 1937, although some of the less important minerals, rock and fossil specimens had to be left behind. In spite of the war, extensive field and laboratory studies have been carried on without any loss of vigour.

To meet the immediate demands of war industry, detailed mapping of mineral deposits occupied the major portion of the institute's geological work, although stress has equally been laid on palaeontological studies and other branches of the science (for example, the excavation and investigation of a complete fossil dinosaur skeleton—the *Lufengosaurus Huenei* Young—from Lufeng Hsien, Yunnan). As to the work in mineral deposits, it can possibly be said that hardly any of the important discoveries and investigations during the last eight years in the western provinces of China have been made without the participation of members of this institute.

The institute, owing to its distance from the main body of the Academy and the difficulty of the Academy in financing it during time of war, is rather isolated and has to go on by itself, although the relation between it and the Academy is still maintained. Dr Wong Wen-Hao himself had to take on the onerous responsbilities of Minister of Economics and Director of the National Resources Commission. In 1945, he became Vice-Chairman of the Executive Yuan and Director of the War Production Board.

Institute of Historical Studies and Archaeology

This Institute owes its birth to the "Committee of Historical Studies" which was formed by the Academy with a group of historians and archaeologists of Peiping as its members. In 1937, circumstances justified the conversion of this committee into the Institute of Historical Studies and Archaeology of the Academy, a more permanent and concrete organization to carry out researches of this nature. Since its foundation this institute, directed by Mr Hsu Ping-Tchang, has consisted of two main divisions,

with Mr Hsu himself in charge of the archaeological division and Mr Ku Chi-Kong leading the historical division.

Regarding archaeological research, a considerable amount of material was obtained in Hopei and Shensi Provinces by excavation and exploration before the war, including the uncovering of many ruined sites of ancient towns. Such materials were examined and studied in the office by a group of members of the institute, such as Mr Su Ping-Chi, Mr Chang Hwei, Mr Ho Loh-Fu, etc. The Institute has published a series of monographs on such archaeological work.

Upon the request of the Shensi Provincial Government in 1934, there was appointed a committee which started an excavation of Tow-Ki-Tai, a ruined site of Pao-Ki-Hsien. Materials of historical significance thus obtained were the remains of many human dwelling places of the Stone Age, also relics of ancient city walls and more than one hundred tombs belonging to various ancient periods. With those materials the first of a proposed series of publications, "Studies of Li-Tripods Excavated at Tow-Ki-Tai" by Mr Su Ping-Chi has gone to press, while the report of the excavation is under compilation.

Historical studies previous to the war involved a detailed survey of the existing temples in and around Peiping, and the antiques available at Peiping ; repunctuation and critique of the Chinese Classic "Shih-Chi" ; studies on the history of development of learning during the Soong and Yuan Dynasties, etc. Many of the results were published in the form of monographs and memoirs while a part appears in the quarterly *Historical Journal* also issued by the institute.

Following the outbreak of the war, the work of this institute, after its move to Kunming, partly from Shensi and partly from Peiping, has consisted mainly of three items : (1) the study of literary materials in connection with ancient Chinese history ; (2) the classification and study of archaeological materials excavated at Pao-Ki-Hsien, Shensi ; and (3) the collecting of historical materials relating to the aboriginals of the bordering zones of China.

Regarding the study of literary materials in ancient Chinese history, several important works have been completed. They are : "The Legendary Period in Chinese Ancient History", a book of seven chapters by Mr Hsu Ping-Tchang, being an investigation based on ancient legends of Chinese history from Huang-Ti to the Middle Shang Dynasty ; (2) "Tsun-Kwo-Tsin-Shy-Hwei-Tien" by Mr Hsu Tao-Ling, (the name index for the holders of the degree "Tsin-Shy" during the various Chinese Dynasties), being a compilation of the historical materials for the last one thousand years.

Items very lately taken up comprise : (1) an essay on Chinese culture in comparison with that of the Western World (a comprehensive and historical study) by Mr Hsu Ping-Tchang ; (2) the work of compiling a general report on the archaeological excavation of Tow-Ki-Tai by Mr. Su Pin-Chi ; (3) studies concerning the philosophy of Wang-Pi by Mr Shang Ai-Sung; (4) studies on the marine treaty between Sung (Chinese) and Chin (Tungus) by Mr Cheng Su-Lo.

A CHALLENGE TO CIVILIZATION*

NIELS BOHR

COPENHAGEN

THE advance of physical science which has made it possible to release vast amounts of energy through atomic disintegration has initiated a veritable revolution of human resources, presenting civilization with a most serious challenge. Man's increasing mastery of the forces of nature, which has provided ever richer possibilities for the growth of culture, may indeed threaten to upset the balance vital for the thriving of organized communities, unless human society can adjust itself to the exigencies of the situation. The great technical developments of the last century already deeply affected the social structure of every country but, evidently, we have now reached a stage which calls for a new approach to the whole problem of international relationship.

The formidable means of destruction which have come within reach of man will obviously constitute a mortal menace to civilization unless, in due time, universal agreement can be obtained about appropriate measures to prevent any unwarranted use of the new energy sources. An agreement to this purpose will surely demand the abolition of barriers hitherto considered necessary to protect national interests but now standing in the way of common safety against unprecedented dangers. In fact, only international control of every undertaking which might constitute a danger to world security will in future

* Reproduced from *Science*, October 12, 1945.

permit any nation to strive for prosperity and cultural development without constant fear of disaster.

Whatever renunciations as regards customary prerogatives such regulation will involve, it should be clear to all that, in contrast to other issues where history and traditions may have fostered divergent viewpoints, we are here dealing with a matter of the deepest interest to all nations. Moreover, the free and open access to information about all scientific and technical progress, which will be a basic condition for the efficiency of the control, will in itself go far towards promoting mutual knowledge and understanding of the cultural aspects of life in the various countries, without which respect and goodwill between nations can hardly endure.

In all the circumstances it would appear that the possibility of producing devastating weapons, against which no defence may be feasible, should be regarded not merely as a new danger added to a perilous world, but rather as a forceful reminder of how closely the fate of all mankind is coupled together. Indeed, the crisis with which civilization is at present confronted should afford a unique opportunity to remove obstacles to peaceful collaboration between nations and to create such mutual confidence as will enable them jointly to benefit from the great promises, as regards human welfare, held out by the progress of science.

The attainment of this goal, which places upon our generation gravest responsibility towards posterity, will of course depend on the attitude of all people. Valuable services, however, may be rendered by scientists all over the world in bringing about a genuine appreciation of what is at stake and in pointing out how the great development of our resources may contribute to progress for humanity. In a matter of such universal scope, help may also be found in the intimate connections between scientists, created by international co-operation which proved so fertile just in a domain of research that was to have such overwhelming consequences.

For meeting the challenge to civilization in the proper spirit it should be a most fortunate omen that we have to do with implications of pure scientific studies pursued with no other aim than to widen the borders of our knowledge and to deepen our understanding of that nature of which we ourselves are a part. Let us hope that the science which, through the ages, has stood as a symbol of the progress to be obtained by common human striving, by its latest emphasis on the necessity of concord, may contribute decisively to a harmonious relationship between all nations.

THE RADAR

S. K. MITRA,
UNIVERSITY COLLEGE OF SCIENCE, CALCUTTA
and
J. N. BHAR,
SECRETARY, RADIO RESEARCH COMMITTEE

Of the many weapons and devices developed during World War No. II, the two epoch-making ones are the Atomic Bomb and the Radar. The former is exclusively a weapon of offence ; it helped the allies to win a quick and decisive victory by its terrible destructive effect. The latter, in contrast, is not in itself directly a weapon of offence. Yet it played a decisive part in winning the war by the invaluable and almost uncanny aid it gave to the major offensive and defensive operations in air, in land and on sea. Further, the atomic bomb in its present stage of development will hardly have any immediate peace time application. The Radar on the other hand can be applied as it is directly to peace time jobs. Readers of "SCIENCE AND CULTURE" have already been told the story of the atomic bomb. In the present article will be narrated the story of the development of Radar—what it is and how it contributed to the winning of the war.

THE PRINCIPLE OF RADAR

Radar or radio-locator may be defined as a device for locating a distant object with the help of radio waves.

In order to locate an object in space with reference to the observer three parameters are needed. These are: (*i*) the range (distance), (*ii*) the bearing and (*iii*) the elevation as shown in Fig. 1. The basic principles of measuring these three parameters with the help of radio waves are as follows:

(*i*) Range (R)—The time taken by radio waves to travel from the observer to the object and, after "reflection", from the object back to the observer, is measured. Knowing the velocity of the radio waves, the distance of the object from the observer is easily calculated.

(*ii*) Bearing (ϕ)—The directional properties of radio receiving aerials are utilised as in standard radio direction finding methods.

(*iii*) Elevation (θ)—The waves returned by the object produce different signal intensities in two receiving aerials situated at different heights above

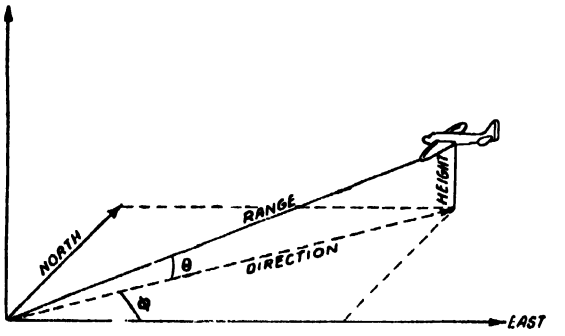
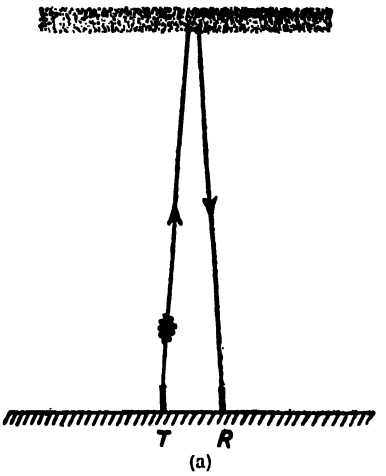


FIG. 1

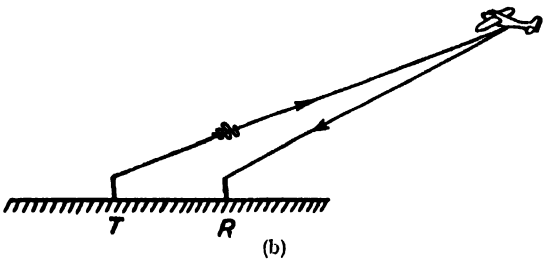
RADIOLOCATION

The observer can locate the aircraft if he knows the three parameters range (R), bearing (ϕ) and elevation (θ).
All the three can be measured by the radar.

the ground according to known law. A comparison of these signal intensities allows one to estimate the height, *i.e.*, the elevation of the object.



(a)



(b)

FIG.

RADIO RANGING BY PULSE TECHNIQUE.

(a) Ranging the ionospheric layer—Bursts (pulses) of high frequency radio waves (1—15 megacycles/sec.) lasting for a very short time (50—100 microseconds) are sent out from the transmitter T. The pulses are reflected back by the conducting ionospheric layer and are recorded by the receiver R. The time of travel of the pulses to and from the ionospheric layer can be measured directly on the screen of a cathode ray oscillograph and yields the height of the reflecting layer.

(b) Ranging an aircraft—High frequency pulses (30–300 megacycles/sec.) of short duration (a few tenths of a microsecond) are sent out from the transmitter T. The reflected pulses are recorded by the receiver. The time of travel of the pulses to and from the aircraft, can be measured directly on the oscillograph screen and yields the distance of the aircraft.

The above principles seem quite simple and straightforward. One may, therefore, wonder why they had not been applied before and wherein lies the novelty. It will however be evident from what follows that in translating these principles into practice tremendous difficulties had to be overcome ; new and special apparatus had to be designed and new techniques evolved at every step.

In what follows we will first explain in some detail the methods of measuring the three parameters as indicated above and then describe the new techniques developed and their applications.

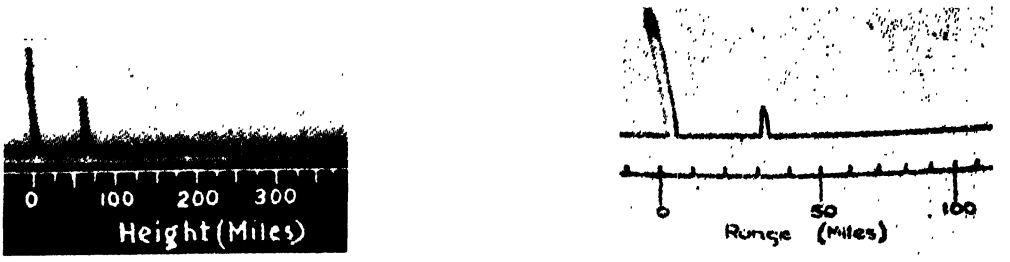
Radio Ranging: The Pulse Technique.—For ranging—that is measuring the distance—the pulse technique, first developed in the U. S. A. by Breit and Tuve for the estimation of the height of the ionospheric* regions in the upper atmosphere, is universally adopted. This may be described as the backbone of Radar.

The principle of the method is quite simple and is illustrated in Fig. 2(a). Pulses of radio waves of short duration are shot upwards from the transmitter T. For each pulse sent out from the transmitter, the receiver R picks up in succession two pulses—first, the ground pulse travelling along the direct path from T to R and a little later, the echo, travelling from T to the ionospheric layer and thence, after reflection, back to R. These two pulses are recorded on the time base of a cathode ray oscillograph connected to the output of the receiver, and produce a pattern as shown in Fig. 3(a). The separation between the two pulse traces along the time base is obviously a measure of the interval that elapses

* The Ionosphere—popularly called the radio-roof of the world, consists of ionized regions which reflect radio-waves. These regions are produced by the ionising action of extreme ultra-violet rays of the sun on the upper atmosphere. They extend from one to four or five hundred kilometres above the surface of the earth.

between the arrival of the ground pulse and that of the echo ; and, if the receiver is close to the transmitter, this is equal to the time taken by the pulse to travel to and from the ionospheric layer. The delay corresponding to this separation being known from the recurrence frequency of the time base, the height of the ionospheric layer can be easily calculated knowing the velocity of the radio waves. In effect, therefore, the time base serves as a scale of heights which may be permanently indicated on the oscillograph screen.

a very small fraction of the energy incident upon it. In fact it is far less than the fraction of energy reflected back by extended surfaces like an ionospheric layer. It follows therefore that the pulses sent out by the transmitter for the radio location of small objects should be much more powerful than those employed for ionospheric ranging. To compare, while pulses with a peak power of a few kilowatts suffice for ionosphere exploration, those required for radar work must possess a peak power of several hundreds of kilowatts.



(a) (b)

FIG. 3

PHOTOGRAPHS OF PULSE RECORDS ON CATHODE RAY OSCILLOGRAPH SCREEN.

(a) Echoes from the ionosphere (Taken at Calcutta)

(b) Echoes from aircraft (Taken in England)

The signals on the left are the pulses reaching the receiver directly. Those on the right are the echoes. The distance between the two along the time base (the horizontal line) measures the time of travel of the pulse to and from the reflecting object and is proportional to the range. The scale is marked below.

The above method of ranging the ionosphere can evidently be extended to determine the distance of any object as illustrated in Fig. 2(b), provided it returns the radio waves with sufficient intensity and also provided the duration of the pulse is sufficiently small such that the echo returned by the object reaches the receiver clear of the end of the direct ground pulse.

For such extension of the pulse technique to the ranging of nearer objects of limited size, the two requirements are: firstly, production of pulses of extremely short duration and secondly, packing sufficiently high energy within a pulse. The reason for using pulses of very short duration is obvious. The time taken by radio waves to travel to an aircraft, say 10 kilometre away and return to the observer is about 60 microseconds. And, in order to be of any practical value, this has to be measured with an accuracy of a few tenths of a microsecond or even less. To achieve this, pulses of radio waves of extremely short duration—a few tenths of a microsecond—are necessary.

Again, the energy returned by a small object like an aeroplane in the direction of incidence is only

To appreciate how small is the fraction of the energy sent out from the transmitting aerial that is received back after being returned by the object, one should remember that the latter varies inversely as the eighth power of the distance as shown by the following formula. The formula refers to the case in which the transmitter, receiver and the scattering object are not so high as to be unaffected by ground reflection. The transmitting and receiving aerials are half-wave dipoles situated close to each other and the wavelength used is greater than the dimensions of the scattering object which for simplicity is assumed to be a metal sphere. Under these conditions, the signal power available at the receiver may be shown to be given by

$$p = \frac{504\,\pi^7\,h_r^4\,h_s^4\,r^6}{\lambda^6\,d^8}\,P$$

where,

h_r—height of the receiving aerial
h_s—height of the scattering sphere
r—radius of the scattering sphere
λ—wavelength used
d—horizontal distance from receiver to the scattering object
P—power radiated by the transmitter.

The formula assumes that the distance of the object from the receiver is much greater than its height above the ground.

To estimate the fraction of the energy radiated by the transmitter that is available at the receiver, for a concrete case, let us take: $h_r = 100$ metres; $h_s = 1000$ metres; $r = 0{\cdot}5$ metres; $\lambda = 10$ metres and $d = 200$ kilometres. For these values

$$p = 9{\cdot}3 \times 10^{-25} P$$

Thus if the transmitter power is 100 kilowatts, the signal power available is of the order of 10^{-19} watts. It should be remembered that this estimate is based on the assumption of a perfectly conducting sphere as the scattering object. If it is not a perfect conductor the energy received will be even much less.

Now these two requirements—shortening the pulses and increasing their peak power—are not incompatible with each other. With a given average power rating of the generator, the peak power of the pulses produced will be greater as the duration of the pulse is made smaller. But there are other factors which impose a limit to the narrowness of the pulses. It is well-known that the narrower the pulse the wider are the side bands associated with the main carrier frequencies. For efficient reception of very short pulses, the receiver is therefore required to have correspondingly wide pass-bands.

A quantitative estimate of the required bandwidth of the receiver may be easily made. It is known that a square-topped radio frequency pulse is composed of a carrier and a continuous set of side bands extending up to infinity, on both sides of the carrier frequency. The energy of the pulse is mostly concentrated within a frequency band the width of which is inversely proportional to the duration of the pulse. To be more precise, if T is the duration of the pulse, the frequency band within which most of the energy is confined spreads from $f - \frac{1}{T}$ to $f + \frac{1}{T}$, where f is the carrier frequency; *i.e.*, the effective band width is $\frac{2}{T}$. As an example, if the pulse is 1 microsecond long, the receiver must be able to accept a frequency band at least 2 megacycles wide in order to record the pulse with sufficient strength and without appreciable distortion. Technically this may be expressed by saying that the width of the receiver pass-band should be 2 megacycles.

Now the random noise from unwanted disturbance sources in a receiver is proportional to the band width. The pulses cannot therefore be shortened indefinitely, even if it were practically possible to do so. For then, the noise in a receiver designed to receive such extremely short pulses would be so great as to drown the echoes altogether. This imposes a limit on the shortness of the pulses which is of the order of a few tenths of a microsecond.

Determination of Bearing.—The method of obtaining the bearing of the object does not differ materially from the conventional Bellini-Tosi or Adcock practice employed for ordinary direction finding by radio. The aerial system consists of two crossed horizontal aerials—half-wave dipoles—at right angles to each other, each of which picks up the signal returned by the object. The outputs of the two dipoles are fed to a radio goniometer which consists of two identical pairs of stationary coils, one pair for each dipole, so mounted that the plane of each pair is parallel to the corresponding dipole. In the space between these stationary coils, is mounted a search coil free to rotate about its own axis. The output of this search coil, after being detected and amplified to the desired degree, is fed to an indicating device, usually the cathode ray oscillograph, which records the received pulses. It can be easily shown that the intensity of the pulse output will be a minimum if the plane of the search coil is at right angles to the direction of the object. The bearing of the object can thus be determined by adjusting the position of the search coil for minimum response.

Measurement of Elevation.—The principle underlying the method of height determination is as follows. The signal returned by the object to be located travels to the receiving aerial via two distinct routes—one direct and the other after reflection at the ground which behaves nearly as a perfect reflector for radio waves. This is illustrated in Fig. 4. Now, the reflected wave suffers a phase lag behind the direct wave due to two causes: firstly, that due to the increased length of path traversed, and secondly

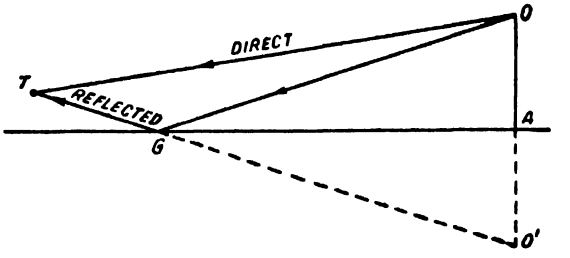


FIG. 4

PRINCIPLE OF HEIGHT FINDING.

T—Receiving aerial
O Flying aircraft scattering back the pulse energy
AG—Ground.

In the vertical plane passing through T (perpendicular to the plane of the paper) there are maxima and minima due to the interference of the direct ray and reflected ray coming apparently from O′ the image of O. It is obvious that the intensity of the signal received by T depends on its location in the interference pattern. In other words the intensity is a function of the height of T above the ground. (The arrangement reminds one of the interference pattern as observed in the Lloyd's mirror experiment in optics. As in the case of Lloyd's mirror, there is a minimum of intensity at the surface of the "mirror", *i.e.* at the ground).

to the 180° phase reversal caused by the reflection at the ground. It is clear that if the aerial is very near the ground, the path difference between the reflected and the direct waves is negligible and therefore the 180° phase difference produced by ground reflection causes the direct and the reflected waves to cancel each other resulting in a very weak signal. As the aerial is moved higher up the increasing path difference annuls more and more the 180° phase difference caused by reflection and eventually a height is reached when the two exactly neutralise each other, resulting in maximum signal strength. This aerial height, it may be noted, is dependent upon the wavelength, the height of object above ground and its distance from the aerial, *i.e.*, the range. It is evident, therefore, that if two identical aerials are placed one above the other (within the height corresponding to the first signal maximum) then the higher aerial will give a signal output greater than the lower one. In fact, for low angles of elevation, the signal intensity is proportional to the square of the product of the height of the object and that of the aerial. By comparing the signal outputs of the two aerials, the height of the object can therefore be determined.

In practice, however, ground conditions vary from place to place and the surroundings also change. These have to be taken account of in estimating the height. This is done by conducting frequent test flights at each place where the Radar is installed and suitable calibration charts are prepared from which the height can be read off directly.

The First Applications of Radar—the CH and the CHL Stations

The first step in the development of radar—so far as England is concerned—was taken when in 1934 one of the officials of the Committee set up by the Air Ministry for Scientific Survey of Air Defence met an official of the National Physical Laboratory with the problem of devising some means of detecting aircraft approaching the shores of England beyond optical range. The members of the N.P.L. who were familiar with the ranging of the ionospheric layers by the pulse technique suggested that the same technique might be applied because the body of the aircraft might scatter back the pulse energy sufficiently for its location by a suitable receiver on the ground.

Preliminary experiments carried out in May 1935 showed that the suggestion was perfectly practicable; echoes from aircraft were detected, as clear (Fig. 3(b)) and powerful as those returned from the ionosphere demonstrating that the method could be successfully applied for ranging aircraft. Immediate decision was made and as early as December, 1935 a chain of five stations (termed CH—Chain Home) was established on the east coast of England. Each of these stations consisted of a transmitter and receiving equipment with suitable aerial systems, shown in Fig. 5,

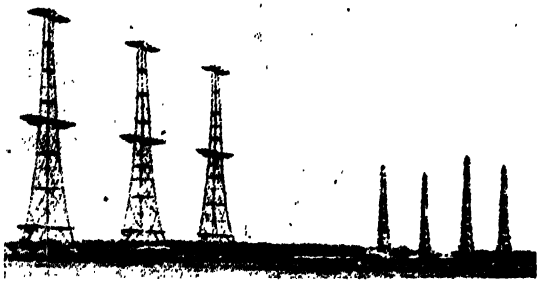


Fig. 5

Transmitting and receiving aerials CH (Chain Home) station.

which could "flood" with radiation the space away from the coast. The wavelength employed was of the order of 10 metres. Any aircraft coming within this "flood-lit" space which extended up to about 300 kilometres from the coast, would scatter the radio energy back towards the coast. The reflected energy picked up by the receiving aerials, situated not far from the transmitter, would be delivered to three highly sensitive receivers which enabled the observers to measure respectively the range, the bearing and the elevation. A continuous chain of such stations giving protection to the eastern coast of England was set up by September, 1939 and in September, 1941 the entire coast of England was covered.

The system however suffered from a great disadvantage. The transmitting aerials situated as they were could not send out sufficient energy grazing the ground. The result was that a distant aircraft could be detected only when it was at a considerable height—about 5000 metres above the ground. This defect could be eliminated by raising the height of the transmitting aerial and/or by decreasing the wavelength. There were practical difficulties to increasing the height of the aerial above a certain limit. The only other alternative was therefore to decrease the wavelength. This was done and a further chain of radar stations—CHL (Chain Home, Low)—using 1·5-metre waves was set up enveloping practically the entire coast. Unlike the 10-metre Radar which flood-lit a wide space, the transmitting aerial for 1·5-metre Radar, shown in Fig. 6, was so arranged as to produce a comparatively narrow beam 12° to 15° in width. The aerial system was mounted on a turntable and the beam could sweep the horizon through the whole 360°, if necessary.

It is to be remembered that the transition from the 10-metre to the 1·5-metre Radar was not an easy job, necessitating the development of many new apparatus and techniques. For instance, novel types of valves had to be designed and produced capable of generating sufficient power at this high frequency.



FIG. 6

RADAR PROTECTION OF ENGLAND.
Transmitting aerial of a CHL (Chain Home, Low)station.

These early warning CH and CHL stations were the first applications of Radar and the aerial protection (Fig. 7) they gave saved England in the critical months of the Battle of Britain.

CENTIMETRIC RADAR

Simultaneously, with the development of the CH and CHL stations, other devices employing radar technique were also being evolved for use in the army and the navy such as search-light laying, gun-laying, detection of enemy vessels from air and the like. Complete miniature radar stations were also in demand for use of the aircraft with which they could spot and even fire on enemy planes in dark and cloudy nights. These and other applications of radar technique, needed more narrow and concentrated beams of radiation. This could only be achieved by reducing the wavelengths still further, so that small parabolic reflectors could be used for concentrating in a particular direction the energy radiated from an aerial.

High Power Magnetron.—The problem of the generation of such short waves, only a few centimetres in length—microwaves as they are called—was solved by a group of scientific workers in the University of Birmingham by developing the well-known magnetron which for a long time had been in use as a laboratory apparatus for production of centimetre waves. The power generated with ordinary magnetrons, however, is small and wholly inadequate for radar purposes. It is reported that the successful evolution of the high power magnetrons was due to the adaptation of the cavity resonance principle. Unfortunately full details of the device are not yet available. But it is known that magnerons capable of generating microwaves of a peak power rating of several hundreds of kilowatts have been developed.



FIG. 7

The area bounded by the outer shaded line was covered by CH stations which could direct high-flying aircraft (5000 metres or more) penetrating it. The inner crossed line indicates the boundary of the region covered by CHL stations which detected low flying planes (150 metres or more) creeping towards the shore.

The obvious and, from the operational point of view, very great advantage of centimetre waves was the ease with which they could be concentrated into a narrow beam of radiation with the help of relatively small parabolic reflectors. The transmitting equipment with its aerial and reflectors now constituted what in effect was a radio search-light. An immediate

application of this was in the detection of low flying aircraft. It has already been mentioned that the longer waves could not be directed close to the ground with sufficient intensity and, therefore, low-flying planes escaped detection. The narrow concentrated beam of centimetre waves could be sent grazing the ground and thus enable the detection of low-flying aircraft.

The Overlapping Beam Technique.—The possibility of producing narrow beams also led to the development of a device of unprecedented accuracy for measuring the bearing of an object. The narrow beam pointing towards the target so as to get the maximum intensity of the echo, itself gives the bearing—both azimuth and elevation. But the accuracy obtained in this way is not enough for operational purposes. An extremely ingenuous device the overlapping beam technique—was therefore evolved. This has been described as one of the landmarks in radar development. The transmitter is provided with two aerial systems with suitable reflectors which can send out two narrow beams of radiation partly overlapping each other as shown in Fig. 8. The aerials are energised alternately in quick succession. It is obvious that the strength of the signal returned by the object as recorded on the oscillograph screen will depend upon the part of the beam in which the object is situated. The two signals corresponding to the two beams will be of equal intensity only when the object is on the line about which the two beams are symmetrically situated. The estimation of this equality can be made with great accuracy thus increasing the accuracy of the bearing. While the usual methods of bearing determination permit an accuracy of 1 or 2 degrees, the overlapping beam technique enables one to measure the bearing with a precision of 5 to 10 minutes.

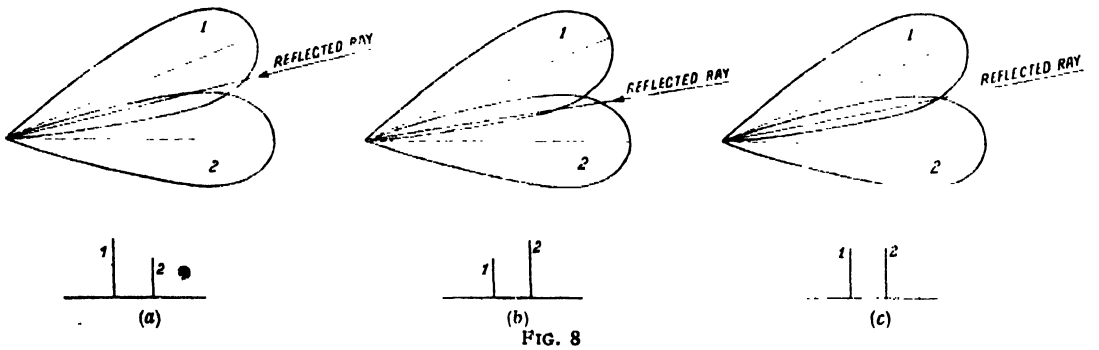


FIG. 8

OVERLAPPING BEAM TECHNIQUE.

The centimetric radar sends out alternately in quick succession two narrow beams of radiation 1 and 2. The line marked "Reflected Ray" represents the direction of the target. If it is on the crossing point of the two beams the two echoes will be exactly equal as shown at (*c*). Slight deviations from this point will result in inequality of amplitude of the two echoes as shown at (*a*) and (*b*). The vertical lines marked 1 and 2 represent the amplitude of the echoes due to the respective beams. The adjustment of equality can be so accurately made that the bearing of the target can be measured within 5 to 10 minutes of arc.

Operational Aids by Radar

With the continued improvement of technique the principle of radio-location was rapidly extended in various directions. Many devices of great operational value were developed, some of which are described below.

IFF (Indicator Friend or Foe).—An instance of the operational application of radar technique is the friend or foe indicator. This is a device fitted on friendly aircraft which responds strongly to the pulses incident on it and sends back the signals modified. At the sending station these are easily distinguished from the unmodified pulses sent back by enemy planes.

PPI (Plan Position Indicator).—Another instance of the application of radar technique is the PPI. In it the aerial system sends out a narrow beam of radiation which is made to sweep round the horizon at a constant speed of about six revolutions per minute. The time base, which is arranged to extend from the centre to the edge of the oscillograph screen, is also made to rotate in a circle in exact synchronism with the beam. Further, the electron beam of the oscillograph is so controlled that a received impulse, instead of producing a notch on the time base as usual (Fig. 3), produces a brightening of the spot. Thus when the beam in its sweep encounters an object, say an aircraft, this is revealed as a bright spot on the screen,—the position of the spot indicating the position of the aircraft on the plan, so far as its direction

and slant range are concerned. This is illustrated in Fig. 9. If further the aircraft is a friendly one carrying the IFF device, the nature of the bright spot at once reveals it. Such delineation of an aircraft or a formation of them on the oscillograph screen indicating their position even in the darkest of nights is of extreme importance for operational purposes.

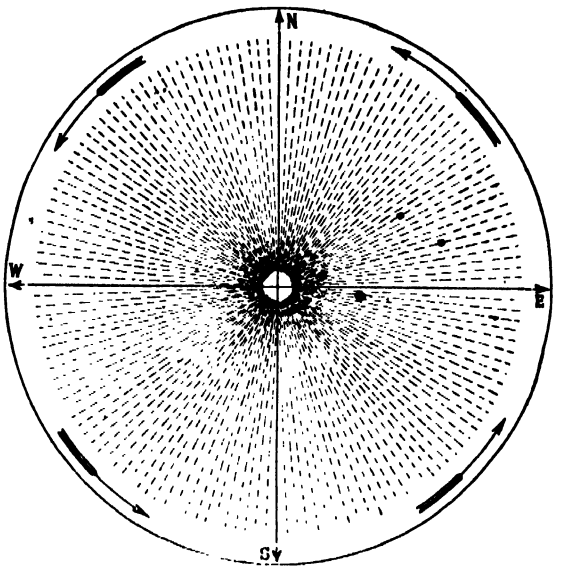


FIG. 9

DIAGRAMMATIC REPRESENTATION OF PPI (PLAN POSITION INDICATOR) RECORD.

The time base, which starts from the centre and travels out radially, is made to rotate in exact synchronism with the beam of radiation sweeping round the horizon in search of enemy planes. An aircraft situated in any direction within range sends back an echo when the beam points towards it. The echo produces a brightening of the time base at a distance from the centre proportional to the range of the aircraft. The position of the plane is thus indicated directly on the plan. The three spots in the diagram indicate the presence of two planes situated approximately 15 North of East and one situated 30 North of East.

ASV.—A modified version of the PPI is the ASV which was devised specially for U-boat detection from the air or from surface ships. The strategic importance of this device will be appreciated if it is remembered that it solved the extremely difficult problem of spotting such small objects as periscopes of submarines, hardly projecting 5 or 6 ft. above the water, in the vastness of the oceans even in the darkest of nights.

H2S.—Another extension of the PPI was the H2S equipment which may perhaps be called the most spectacular application of the radar technique. With the help of this equipment one can obtain on the cathode ray oscillograph screen a vivid representation of the landscape extending up to 10 miles or more round a point distinguishing between rivers, seas, lands, forests, cities and villages. The H2S device which is generally fitted on aircraft, directs the rotating beam of radiation towards the ground slantingly. The pulses on striking the various features of the landscape such as water, land or metallic structures are returned towards the sender with varying intensity and produce on the oscillograph screen spots of varying degrees of brightness. Thus a stretch of water which, on account of its smooth surface, reflects the pulse energy incident on it away from the sender, appears dark on the oscillograph screen. On the other hand, cities and towns having large metallic structures scatter the pulse energy back in the incident direction relatively copiously and appear quite bright. Open fields scatter back the incident

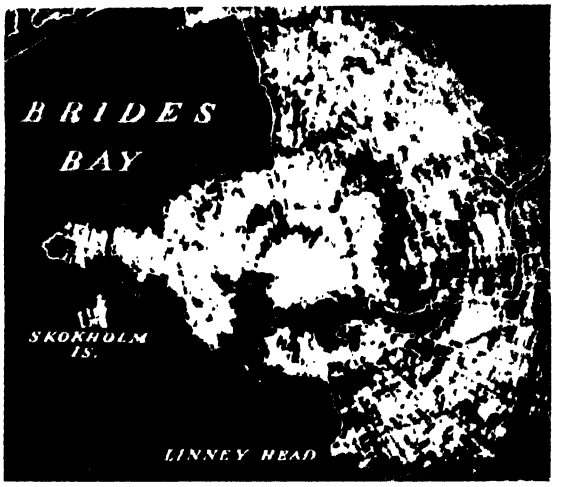


FIG. 10

RADAR MAP.

The pulses sent out from an airborne radar strike the various features of the landscape and are returned with varying intensities producing on the oscillograph screen a pattern which shows clearly rivers, lakes, seas, cities and villages as in a map. The above photograph was taken with a H2S equipment from an aircraft flying over Pembroke on the south west coast of England. The white continuous line is drawn on the photograph to show the actual coast-line. The similarity between the photograph and the landscape below is remarkable.

energy in a moderate degree and therefore appear as of intermediate brightness. An actual radar map obtained with the help of a H2S equipment carried on a night bomber is represented in Fig. 10.

It should be mentioned here that the success of both the H2S—the aid to town finding, and the ASV —the aid to U-boat spotting, was made possible by the use of centimetre waves. In the early stages both were developed as a common equipment known as H2S/ASV.

GCI (Ground Control Interception).—The CHL station in conjunction with a PPI set formed what is

described as the GCI system. With the aid of this system a fighter plane could be guided to the neighbourhood of the enemy aircraft within 3 to 6 kilometres. In dark nights or in bad visibility, the fighter would use the AI (Air Intereception) set in it and guide itself close to the enemy planes for attack. It is said that it was this combination of the CH/CHL stations on the coast, the GCI equipment inland and the AI set on the night fighter that was responsible for successfully fighting the Battle of Britain during the nights in the early months of 1941.

Gee.—The Gee system does not depend on the reception of echoes but utilises the pulses and all its associated technique in a different way. It is said to be the most widely installed of all radar systems. With this system a night flying aircraft can find out its position on the map with the accuracy of a few kilometres square at a distance of about 500 kilometres. The principle on which the system operates is as follows. Synchronous pulses are sent out from three suitably located ground stations. The aircraft carrying a pulse receiver and picking up these pulses cannot of course know its distance from any of the pulse senders. But the pilot can measure the time difference of the arrival of pulses sent out from any one pair of the three senders which, in other words, is also the difference in distance between him and this pair of senders. He thus knows the particular hyperbola, characterised by a constant distance difference from these two sending stations, on which he is. He can also, at the same time, find out from the time difference of the arrival of pulses sent out from the other pair of senders another characteristic hyperbola on which he is. The intersection of these two hyperbolas gives him his position on the map. The accuracy obtained with this system, as already stated, may seem quite high, but even this was not found to be enough and the "Oboe" described below was therefore devised.

Oboe.—In this system two ground stations send out pulses which are returned from the bomber carrying a device similar to the IFF set, whose delay time is very accurately known. The craft is so controlled by one of the ground stations A (to which it is constantly sending response pulses) that it flies in the arc of a circle round A, the radius of which is equal to the distance of the target to be bombed. The receiver at the pulse sender B knows its own distance from the target and can also measure the distance of the aircraft at every instant. The observer at B thus knows the distance of the flying aircraft from the target to be bombed at every instant and can appraise the aircraft the exact time at which it is over the target and is to release the bomb. The accuracy of bombing by the Oboe is said to be within 200 metres at distances of about 300 kilometres.

GL and SLC.—The GL equipment using centimetre waves was meant for controlling gun fire at unseen enemy targets such as aircraft or flying bombs. The precision of measurement of the range, bearing and elevation by this equipment is very great indeed. The accuracy far exceeds that of the guns themselves and the data, when fed to the AA predictors, enable them to bring under successful fire, flying bombs during night time. In fact the success of the equipment was so great that 80 to 100% of the flying bombs approaching towards the coast were accounted for.

The problem of "Blind Fire" was also solved with the help of radar using 1·5-metre waves. Measurement of range of distant targets on land or at sea could be made with far greater accuracy than was possible by ordinary visual methods. This enormously increased the effectiveness of artillery fire on land and on the sea.

Radar controlled search lights also played a great part for defence against night raiders. With their help the operator could so direct the search light as to illuminate the enemy aircraft while leaving the attacking plane in the dark. The latter would thus get close to its kill and make surprise attack on the enemy without disclosing its position. With the help of centimetric Radar a search light can also be controlled in such a way that it automatically unmasks itself as soon as the target is in its line. This system is known as Elsie or SLC.

We have in the preceding paragraphs dealt with the main landmarks of the development of radar and described the basic principles on which the system works. We have described how the wavelength has been pushed to shorter and shorter limits, from 10 metres for the coastal CH stations to 1·5 metres for the CHL stations to 10 cms. for use in small equipments to be carried in aircraft and such other appliances as the H2S, ASV, etc. It is now reported that the wavelength has gone down still further to 3 cms. The useful application of these higher and higher frequencies, hitherto unknown in radio engineering, demanded continued development of new methods, apparatus, circuits and technique. Successful solution of the many problems, novel and at the same time urgent was only possible by the wonderful teamwork to which we will refer presently.

It is interesting to mention here that the use of centimetre waves has brought us back to the early days of Hertz, Lodge, Bose and Marconi when electromagnetic radiation first began to be studied. We may recall here that Sir J. C. Bose performed very delicate experiments with waves even smaller than a centimetre (Fig. 11) to demonstrate the reflection, refraction and polarisation of the waves. Many of

these experiments are now being repeated for application towards practical ends. As a matter of fact some of the apparatus at present in use in some of the training laboratories are almost identical to those used by Bose in his experiments carried out half a century ago.

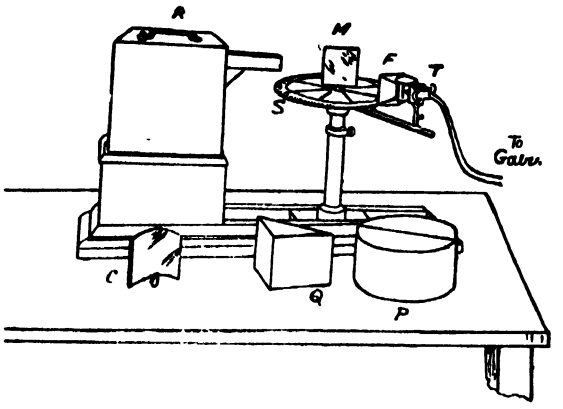


FIG. 11

SIR J. C. BOSE'S APPARATUS FOR DEMONSTRATING PROPERTIES OF CENTIMETRIC WAVES DESIGNED HALF A CENTURY AGO.

The box R houses a spark transmitter generating 0·5 centimetre waves. S—spectrometer table; M—plane mirror for reflection, C cylindrical mirror, P—semi-cylinder enclosing an airfilm to demonstrate total reflection; Q—total reflecting prism of porcelain; F—collecting funnel attached to the receiver.

It is interesting to note that Sir J. C. Bose used crystal detectors which have now again come into use and are considered to be the best detectors for microwaves. A horn analogous to the funnel is also a very common feature in the most modern microwave transmitting and receiving equipments.

(Adapted from a drawing in reprint of Friday Evening Discourse, Royal Institution, London, January 1897.)

RADAR WORK IN OTHER COUNTRIES

While much work in the early stages and in the development of radar in its present form was done by British scientists it must be pointed out that the contributions of workers in other countries, particularly in the U. S. A., were no less important. As a matter of fact it was the most intimate collaboration between British and American scientists under the pressure of war that made possible the successful development of radar within such a short space of time. Naturally the publication of all information regarding the work done on radar in other belligerent countries was restricted at the outbreak of war and the years just preceding it ; but from whatever scanty information was available before the war, it is evident that investigations on the technique of radio-location were in progress in France, Germany, Italy and Russia. France perhaps is the first country to have made public the practical use of radio-location by fitting on board the "Normandie" an 'obstacle locator' which would locate a coast-line from a distance of about 20 kilometres and large ships and icebergs within a range of 6 to 7 kilometres. It is interesting to mention here that this device made use of centimetric waves (16 cms.) and parabolic reflectors both for the transmitting and receiving aerials and may be considered as the true forerunner of the modern centimetric radar. In Germany, the Telefunken Company was engaged in the development of various devices for radio-location during the years preceding the war. In Italy also some investigations on the radio-location of ships and aircraft were being conducted at the same time.

In the U. S. A., experimental investigations on the radar technique were started in the Naval Research Laboratory at the time when the British scientists were engaged in similar work. The first practical aid to flying based on the principle of radio-location was developed at the Bell Telephone Laboratories in the form of an aircraft altitude meter. Since 1939, these laboratories in close collaboration with Western Electric Company and the Radiation Laboratory under the National Defence Research Committee have played an outstanding part in the design, development and production of radar. Special mention must also be made in this connection of the development of the klystron, which, though invented just before the war, was perfected by the Varian brothers during the war in the Stanford University. This new type of valve utilising the velocity modulation principle and a cavity resonator has been successfully used as the local oscillator for generating very high frequency oscillations required for the superheterodyne receivers of the radar equipment.

The extent of radar development in the U. S. A. and its applications during the war may be gauged from the fact that up to the middle of this year approximately $2,700,000,000 worth of radar equipment had been supplied to the Army and Navy. Nearly 100 different varieties of radar, each meant for a special purpose, were designed and produced in the U. S. A. alone ; the largest unit weighs more than 30,000 kilograms and consists of near-about 400 valves while the smallest unit may weigh 50 kilograms having a complement of 70 or 80 valves.

THE LESSONS OF RADAR

The phenomenal development of Radar or the art of radio-location within the short space of seven or eight years teaches many lessons which should be borne in mind by every nation planning for progress. Firstly, it has shown the value of collaboration between scientists with wide outlook on the one hand and military authorities on the other. It has led to

development of weapons of unprecedented military value in entirely novel directions. Such collaboration is no doubt a bold departure from the age-old tradition of the military department. But the results derived therefrom have clearly shown how wasteful from the national point of view had been its lack in the past.

The second lesson is that of the value of team-work between scientists of different groups. A devoted band of workers, each attacking a particular aspect of a problem but working in close collaboration with others, can solve a problem in months which would otherwise take years. One of the authors of this article had the opportunity of attending the meeting of a panel set up for the study of micro-wave propagation during the war. There were about 20 workers on the panel consisting of physicists, mathematicians, electrical engineers, radio technicians and meteorologists. Each of the members had undertaken to study closely a topic which is related to his own line. The contributions from all these workers when co-ordinated helped to arrive at a solution of the problems within the shortest possible time.

Thirdly, the success of radar serves as a forceful illustration of the fact that a country in order to be militarily efficient must have its industries in all branches highly developed. The researches conducted require at every step specialised apparatus and improvements on existing ones. And these can be supplied by the industries concerned only if they are highly developed. Further, there is always a big gap between the experimental development of an equipment in the laboratory and its large scale factory production. Only in a highly industrialised country, with the industries whole-heartedly co-operating with the research organizations, can the quickest and most fruitful results be achieved.

Fourthly, behind all these efforts must be the fullest and most liberal backing of the State. This is a fundamental necessity and if in peacetime results anywhere comparable to those achieved during war-time are aimed at, State aid is imperative.

But, perhaps the greatest lesson of radar is the indispensability of the presence in the country, whether in peace or in war, of a large body of independent scientific workers of wide outlook and flexible mind. Such men should be allowed to pursue their own lines of study and methods of attack rather than regimented for tackling problems which need immediate solution.*

* One of the authors (J. N. B.) is indebted to the Director, Scientific and Industrial Research, for kindly permitting him to collaborate in the preparation of this article.

RIVER TRAINING IN U. S. A.

KARTIK CHANDRA NIYOGI,
RESEARCH OFFICER, RIVER RESEARCH INSTITUTE, BENGAL

Of Water and Mountains

NEXT to the soil, the most important resource of a region is its water. All the water on the earth falls from the heavens, but the heavens frequently do not drop it where it does the most good. The rich prairie withers under the water-hungry sun while the craggy mountain tops are drenched in rain and buried under snow. In this natural drama the mountains are at once the great oppressors and the great benefactors. They shield the adjoining valleys, for example, from the freezing winds and keep them warm and sunny and fertile. But they are so high that they catch most of the moisture in the damp winds blowing in from the ocean and leave little for the valleys below. Even in the spring, when the snows on the mountains melt and the rivers carry the water away to sea, little is left for the valleys. Such has been the story of so many watersheds on the surface of the earth. And it is man who has made the story different. Man has simply caught the water in the mountains and stored it behind dams. A dam is essentially for holding back water during the wet months when it is not needed downstream and release it when most needed. During this release of water it will develop power, it will aid navigation and flood control. This is the first picture that strikes the eye when considering a storage plant. However, its significance is deeper still when the more fundamental purposes in the development of an entire watershed are understood. Development of a 'yard-stick' by which to measure the cost of generation and distribution of electricity and to find ways to widen its use is but one of the aspects of the scheme. The development of new and better forms of fertilizers or plant foods is another vital one, the problem of stopping the erosion of the soil is another ; the maintenance of a proper balance between agriculture and industry to avoid stagnation of either in the future is a fourth ; the reforestation of wide areas which are sub-marginal is another. And there are many more. All, however, have a common aim—the utilization of the resources of an entire watershed so that the burdens of life are reduced to a minimum.

All are inexorably bound together if the common aim is to be achieved ; and all must be retained in one's mental background when considering the real importance of any such project as that of the River Training and of the damming of any important

The Upper Mississippi

Extending from the Atlantic States to the Great Continental Divide and from Canada to the Gulf of Mexico, the drainage basin of the Mississippi River

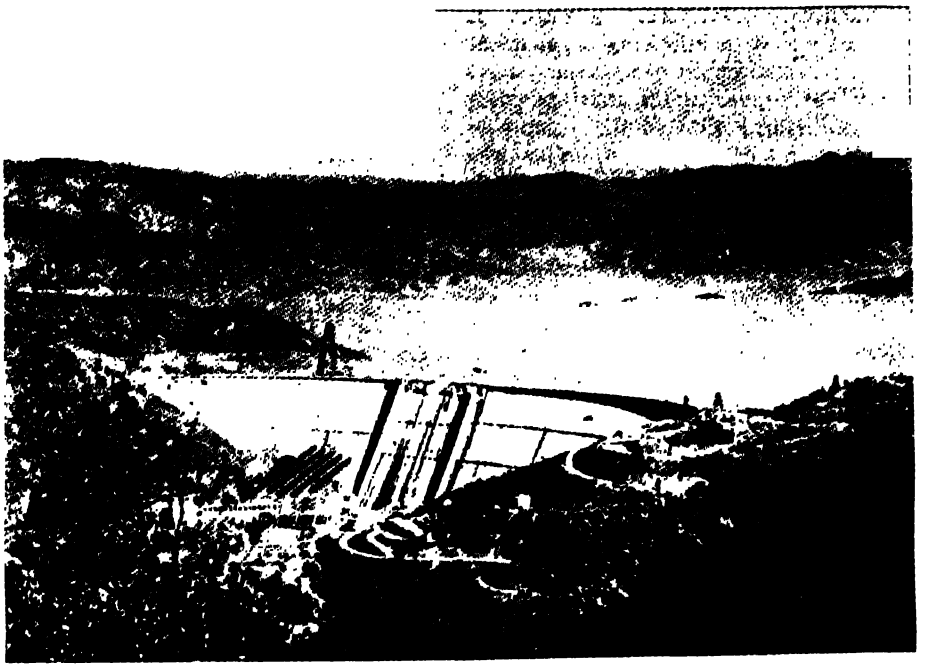


Fig. 1.

How man interferes with water and mountain.

watershed. It should be particularly borne in mind that these dams are monuments not so much to man's engineering and construction skill as to his genius for improving on Nature. Without them the West would never have been so golden.

Many nations and regions, like many individuals are born ambitious and grow up expecting to conquer the world. Not so many achieve the greatness potential in their talents and circumstances. Their critical test comes when they are called on to meet a challenge to their old existence, to overcome a combination of forces they did not create. Looking over to U. S. A., we come across volumes of evidences leading to the acceptance of such brave challenges.

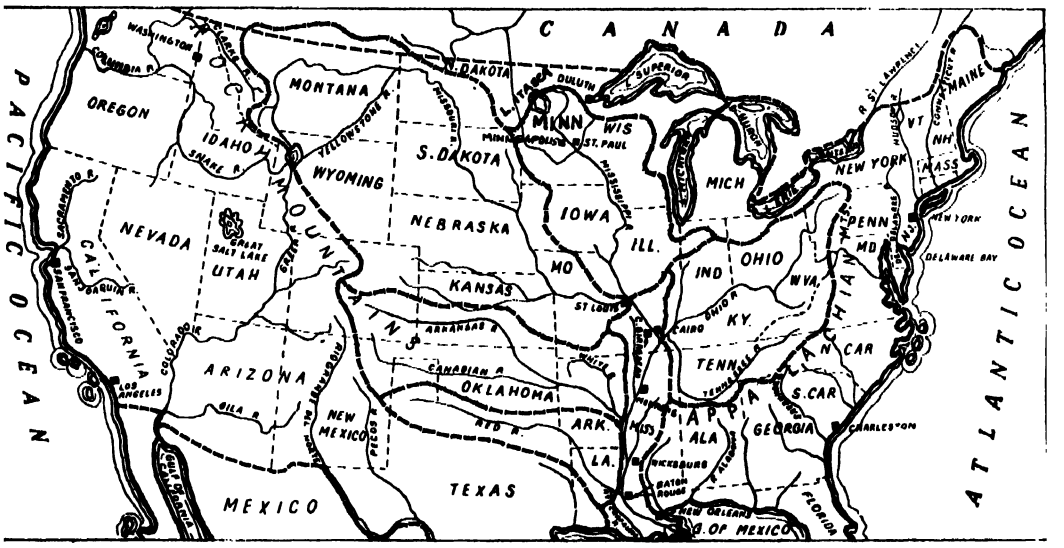
The present article has been compiled with a view to show to the readers the extent to which the Americans have been successful in this direction so far as the training of their important rivers are concerned. The map showing the river systems in U. S. A. has been presented here for the interest of the readers.

includes an area of 1,240,000 sq. miles and covers 41 per cent of the United States an area equal to 2·2 per cent of the entire land surface of the world.

The Upper Mississippi embraces so much of that stream as lies northward of the point where the Missouri meets the 'Father of waters', a few miles above St. Louis, and there were considerable stretches of the river having a depth of 4 ft. only. Boats drawing more than 4 ft. could not navigate during low water stages. The up bound and down bound freight was usually transhipped at St. Louis ; this entailed loss of time and increased cost. Further the prolonged periods of exceptionally low water in the Upper Mississippi revealed that simple dredging in some sections and constructing contraction works in other sections (this latter operation tends to increase the speed of flow and thus automatically prevent silting up and formation of obstruction bars) would not make a successful channel for navigation.

In the Upper Mississippi Valley Minneapolis and St. Paul—familiarly known as the 'Twin cities'—occupy a strategic position in relation to the con-

tiguous and neighbouring States which to a large extent are essentially agricultural in their productive activities. When not hampered by drought and other unseasonable conditions, Montana, North Dakota, South Dakota and Minnesota grow annually a billion and more bushels of grain. Save for the outlet at Duluth, a port in Lake Superior, this immense region—which has the combined expanse of Germany, France, Italy and the British Isles—is, for all practical purposes, land locked. Using Duluth as a port of outlet the grain merchants hopelessly failed to seek a competing market abroad. Had the Mississippi River been available for a trunk line service, the Twin cities and other communities would be able to ship bulk cargoes through to New Orleans and would thus be placed directly in touch with ocean going craft without breaking cargo between numerous villages and small cities ; their industrial development lie along the shores just out of the reach of high water. The tracks of some parallelling railroads are similarly but little above flood levels. Moreover there are rich farm lands lower down on the upper river that are protected from inundation by dykes or levees having their bases always submerged so that seepage on to cultivated areas necessitated almost continuous pumping. The engineers overcame these difficulties by the improved technique acquired during recent times They fixed upon types of dams that would raise the natural flood level of the river at no point more than 12 inches lest property damage be prohibitively great. They used dams of just sufficient height to impound enough water to provide a minimum channel depth of 9 ft. consistent with the changes in the flood level of as much as



RIVERS IN U. S. A.

the shipping point and the Louisiana sea port. And the only feasible solution of the problem came from the U. S. Army Engineers who recommended in 1931 to canalize the river throughout the section in question covering a length of 650 miles by creating 27 pools upstream with an equal number of dams which have, with two exceptions, locks 110 ft. wide and 600 ft. long. The purpose of such large locks is to permit a tow-boat and its group of bargers to pass through a lock without altering its formation, *i.e.*, without losing time in splitting up.

But the Upper Mississippi presented physical difficulties for the execution of such a plan. The river valley is generally broad and flat. At flood stage the surface of its water varies in breadth from half a mile to two miles ; along the banks on each side of the stream and just above flood level are 18 to 21 ft. on the river. Provisions for the avenues of escape of the tremendous volumes of flood water in the form of spillways and spillway gates permitting the normal regulation of the river for navigational purposes are made. The spillway gates are also patterned to free themselves from ice in contact with them and to withstand the pressure of large bodies of such ice which are carried downstream during the winter months. These gates could be opened promptly to allow ice to escape instead of forming disastrous jams.

Besides the transportation of agricultural products from the Twin cities the navigable channel allows the coal and steel companies which, before the said canalization of the Upper Mississippi, operated fleets of barges between the Pittsburgh District and the coal mines adjacent to the Ohio River to send their

commodities to the Twin cities and to other points on the upper valley. In fact the valley which was earlier almost exclusively devoted to agriculture is transformed into a region engaged in different forms of industry and enjoys a balanced economic life.

The Lower Mississippi

This is noted for its frequent but devastating floods. The Lower Mississippi is that part of the 'Father of Waters' that has cut a devious and changing course through a great alluvial valley that extends from Cape Girardeau, Missouri, southward to the Gulf of Mexico with a winding channel way of nearly 1,100 miles. The river with its tributaries draws from an watershed of about 1,250,000 sq. miles area. When a large percentage of the run off from this vast watershed is free to flow into the main stem of the system, the discharge in the Gulf of Mexico is as much as 2,850,000 cusecs. All this water escapes by what is, in effect, the small end of a funnel where the velocity of flow is highest because of the constricted area of the passage. Collected data for the occurrence of overflowing high water established the fact that severe floods occur in the Lower Mississippi on an average of every 2·8 years. And how to save the people from these flood havocs?

The French, who founded New Orleans towards the first quarter of the 18th century, first built a low levee (embankment) along the river side. This levee system has been gradually developed to keep the river within bounds ; prior to the flood of 1927 nearly 21,000 sq. miles of the basin was being protected in this manner from flood waters with of course occasional breaches in the levees which were rebuilt subsequently to an increased height so as not to be overtopped by the river at the crest of a future flood. The system has thus mounted up successively, and, as each new level was reached, the belief was fostered that the system as a whole was high enough and strong enough to meet any likely maximum flood stage. But effective as levees are in many respects, they are not a cure all for flood evils. Time and again the levees had been breached and extensive areas had been inundated by the flood waters of 1927. These facts combined with a very critical analysis of all available data led the Army Engineers to plan control work with a safety margin even for the flood waters to attain a stupendous flow of nearly 3,000,000 cusecs. They raised the crests of the primary system of levees 3 ft. higher than they were in 1927 and instead of placing entire dependence upon levees to hedge in flood waters the experts offered 'channels of relief' to the river side. These flood ways would detour the excess water above a given flood level while the main levees would guide the major volume of the total flow safely onward to the sea. Thus the Atchafalaya on the west with its adjacent low lying territory is used for one such flood way. The Bonnet Carre spillway on the east bank of the river about 40 miles above New Orleans is another the water from which flows into Lake Pontchartrain. Upstream of Vicksburg adjacent to the confluence of the Mississippi and the Yazoo rivers, there is also created a back water area of floodway. Three other back water reservoirs on the west side in Arkansas and Louisiana accommodate temporarily excess flood waters and feed them back into the main stream as the flood level drops down. The defensive barriers set up are counted up on to protect 12,000,000 acres from overtopping waters ; the flood ways and the back water areas together provide emergency relief basins having a total expense of 8,000,000 acres. The floods in the Lower Mississippi is being controlled successfully in this manner.

The Missouri River

The Missouri river covers a length of 2,500 miles, a total fall of 3,630 ft. and drains an area of 528,800 sq. miles. Almost throughout its course the river is a typical alluvial stream characterised by instability of channel, relatively steep and frequently changing slopes, easily eroded bed and banks, and an enormous quantity of suspended materials and bed sediment. This is why the river has become familiarly known as the 'Big Muddy' and this Big Muddy fluctuates greatly in the volume of its flow. At low water stage it discharges as little as 12,300 cusecs while the maximum outpouring at flood stages is nearly 546,000 cusecs with a resulting variation in the height of the river from 16 to 38 ft. according to weather conditions.

During the last 30 years or so, many millions of dollars was spent in improving the river between its mouth and Kansas city, a distance of 388 miles and in turning out from this a fairly stabilized channel having a general depth of 6 ft. at low water. But the need of a channel with a depth of 8 or 9 ft. and its extension from the mouth of the river to the Sioux City, Iowa, a stretch of 768 miles, was felt strongly because of the fact that such a channel would then permit an annual movement of about 12,000,000 tons of freight at a saving of something like 1 dollar a ton. Now to keep such a channel supplied with water at certain low stages, a part of the spring floods must necessarily be conserved and released in sufficient volume to make up deficiencies during other seasons. This is achieved by the Fort Peck reservoir above the Fort Peck Dam in the north-eastern Montana with a capacity of 19,500,000 acre feet of water which feeds the said navigable channel. The Army Engineers Corps., U. S. A., however, had a project of making four reservoirs of

such large capacities so as to stabilize the Missouri River and to reduce its ravages when in flood.

A short description of the construction of the Fort Peck Dam, the largest of the four, will be rather interesting to know. The great majority of modern dams of large size are of masonry construction and commonly built of concrete ; but all such dams are usually set on solid rock or else supported by piles that are driven far enough into an underlying formation to provide the requisite stability. The prevailing depth of the alluvial overburden resting upon the underlying shale made this common procedure impracticable at Fort Peck. What the Army Engineers did in this case was to erect a monster bulwark of earth out of the very mixture of sand, gravel and clay that the river had deposited over a considerable length of time ; these were dredged and pumped into the site for the dam to build up the massive impounding barrier to directly thwart the normal flow of that very river. On the whole 10^8 cubic yards of earth was consumed by the dam and ways and means employed for its construction established new records of engineering performance.

United States Department of the Interior Bureau of Reclamation

Speaking on Reclamation's contribution to the Nation, John C. Page, Commissioner of Reclamation says,—

"It is true that the U. S. could have become a great nation without irrigation, for two-thirds of its territory is humid. But it never would have become so great a nation as it is today without the 20,000,000 acres of irrigated land in its Western States. The economic destinies of more than 13,000,000 people in this arid region and great cities, such as Los Angeles, Phoenix, Salt Lake City, and Denver, rest upon farming by irrigation and the industrial growth made possible by conservation of water. . . . To-day it has a great construction program, the largest in the Bureau's history, which will provide water to about 2,500,000 additional acres, transforming them from sagebrush wastes into productive farms that will support millions. This will bring to 5,000,000 acres the total of new lands the Bureau has watered." At present the Reclamation represents,—

(*i*) Homes, livelihood for 900,000 persons,
(*ii*) $100,000,000 annual yield of crops,
(*iii*) $200,000,000 market for industry,
(*iv*) 3,000,000 irrigable acres,
(*v*) 50,000 irrigated farms,
(*vi*) 250 cities and towns,
(*vii*) 145 dams and 83 reservoirs,
(*viii*) 20,000 miles of canals,
(*ix*) 200,000 irrigation structures,
(*x*) 23 power plants,
(*xi*) Conservation of 60 million acre-feet *i.e.*, 20,000 billion gallons of the arid West's valuable water for
(*a*) Irrigation (*c*) Power
(*b*) Flood Control (*d*) Recreation.

The engineering research laboratories of this Bureau in Denver represent a considerable investment for plant, equipment, instruments and special apparatus, with an operating force of about 130 engineers, scientists, laboratory technicians and mechanics, all specially trained in engineering investigation and testing techniques, while the individual laboratory groups considered separately are not particularly unusual as compared with other similar laboratories, the several units in combination form a versatile and experienced organization for the solution of a wide diversity of technical engineering problems. Selection and utilization of the most suitable materials for engineering purposes, predetermination of the adequacy of engineering designs and of the suitability and applicability of construction or fabrication methods, to the end that structures, equipment and machinery may be designed, built and operated to function as intended, are among the general problems with which the laboratories are most frequently concerned

The Bureau's Denver Laboratory include :

(1) Hydraulic Laboratory,
(2) Earth Materials Laboratory,
(3) Microscopic Laboratory,
(4) Machinery and Metals Testing,
(5) Concrete and Concrete Materials Laboratories,
(6) Chemical Laboratory,
(7) Paint Laboratory,
(8) Photoelastic Laboratory,
(9) General Engineering Investigation Laboratory, and
(10) Shops.

(To be concluded)

SCIENCE AND HUMANITY *

AM reminded of a cartoon which I recently saw, wherein Victory is asked, "Where is Peace?" And she replies, "Peace is a war casualty." Today, although the war has ended and there is what is ordinarily called peace in the world, there is neither a sense of security nor a sense of rejoicing in men's minds. For, as Lin Yutang has remarked, there can

* Adapted from the address delivered by Mr G. L. Mehta as the Chief Guest at the tenth annual meeting of the Indian Science News Association, held at the University College of Science, Calcutta, on 12th September, 1945.

be no peace in the world unless there is peace in our hearts.

The ordinary man has been thrilled, awed, bewildered and is now even frightened of science, especially after the invention and use of the atomic bomb. It has been a shock to moral conscience and it is sad to contemplate, although that is the least part of its horror, that very nearly 70 crores of rupees were spent on research of this destructive weapon.

During this war, there have been remarkable and epoc-making scientific discoveries and inventions like radar and penicillin, and great developments in several directions such as plastics, alloys and light metals. But modern civilization has also given us the blessings of air-warfare, poison gas and torpedoing, which are equally the fruits of science. Science is like the Hindu Trinity of Brahma, Vishnu and Mahesh. It can create, it can nourish and it can destroy. It is the healer and destroyer in one.

Science produces the means, some of which are indeed essential for progress. Witness the advance in Western countries in respect of hygiene, sanitation, public health, engineering and electrical developments. Science is also the product of the Promethean madness that leads the greatest men to strive to become gods. But science, we should never forget, does not determine values for us or show us the ends of life. Science is an instrument. But in the modern world the power of science even as an instrument has become tremendous. To the typical modern mind, nothing is interesting on account of what it is, but only on account of what it may be made to become. The important characteristics of things from this point of view are not their intrinsic qualities but their uses. Everything is an instrument. If you ask what it is an instrument to, the answer will be that it is an instrument for the making of instruments which will in turn make still more powerful instruments and so on *ad infinitum*. In psychological terms this means that the love of power has thrown aside all other impulses that make the complete human life.

Our age is one which increasingly substitutes power for the older ideals and this is happening in science as elsewhere. Science as an instrument of power rather than as a method of arriving at truth is what appeals to the modern mind. What is dangerous is power wielded for the sake of power and not for the sake of genuine good. The leaders of the modern world, says Bertrand Russell, are drunk with power. The fact that they can do something that one previously thought it impossible to do is to them a sufficient reason for doing it. Power, surely is not one of the ends of life but merely a means to other ends. But until men remember the ends that power should subserve, science will not do what it might and can to minister to the good life. Science, in other words, as pursuit of power must not obtrude upon the sphere of values. The world governed by knowledge without love and by power without delight would be a terrible world—a world of robots, of mechanical triumphs. Indeed, it is doubtful if such a world would even ultimately survive.

There are indeed fundamental contradictions in the civilization of the West. They build sky-scrapers and then construct deep shelters far below the earth where they live. They even propose to build factories and towns under the ground for protection against atomic bombs. They have dazzling lights which turn night into day and then have gloomy black-outs for years. They have wonderful hospitals, children's homes, schools and sanatoriums, and they destroy them without pity or remorse. In the next war, it is evident that the side which secures the first blow will win. The idea of a "front" has become as old-fashioned as bows and arrows. People will not have to go to war ; war will come to them. This mass murder is called war. But a good end if it cannot be achieved without wholesale slaughter cannot be achieved at all.

It was suggested at the last meeting of the British Association Conference early this year by Prof. Mackintosh, a Dean of the London School of Hygiene and Tropical Medicine, that science had been too long the Genie of the Lamp and now ought to try to be the Aladdin. Since these words were uttered, Hiroshima and Nagasaki are a reminder of what the Genie is capable of when the Lamp is rubbed the wrong way. The question is, "Could the Genie be turned out, and Aladdin be trusted to rub it the right way?" The Genie at least ought to be consulted before the Lamp is rubbed. It was even suggested by Lord Woolton who was then the Minister of Reconstruction that the Genie might not rub the Lamp but it could apply the brasso! Unless the men of science recognize their vital obligations to the community and are inspired by a moral purpose, science cannot expect to save mankind.

It is certain, however, that the experience gained in war of using not only the results of scientific research and inventiveness, but the scientific approach to the wider problems is indispensable to the solution of the problems of peace. We must have a right conception of the ends of life. Man is becoming so strong that unless he becomes wise he will perish. The West must imbibe some of the wisdom for which it despises the East.

Notes and News

60TH BIRTH-DAY OF PROF. NIELS BOHR

On October 7, 1945, Prof. Bohr completed his 60th birth day. In view of the adverse times it has been possible to celebrate the occasion only by the issue of a special number of the *Reviews of Modern Physics* (April-July 1945) to which scientists of many nations from the three continents have contributed, as expressions of their individual debt and gratitude to Prof. Bohr. Prof. W. Pauli was entrusted with the collection of papers and the editorial work. In an introductory paper, Pauli gives an account of the general development of the fundamental concepts of the quantum theory of the structure of atoms with which Bohr's name will always remain associated.

We quote the following from the introduction:

"Professor Niels Bohr's 60th birthday, on October 7, 1945, is not only his private personal day of celebration, but a day of observance throughout the scientific community of physicists.

"While many outstanding scholars of all times have obtained their fundamental insights in solitary labour secluded from the world, Niels Bohr, thanks to his inspiring personality, has gained contact, in proportion as his scientific work grew and shaped itself, with an ever-increasing number of people among whom he found many collaborators and pupils. After two decisive years in Rutherford's laboratory in Manchester, he returned in 1916 as a professor to his birth-place, Copenhagen, where in 1920 the 'Institut for Teoretisk Fysik' was founded. Soon this institute made Copenhagen attract scientists from all parts of the planet as the 'Capital of Atomic Physics'. As director of the laboratory which was attached to the institute, Bohr found an opportunity along with his main theoretical work, to supervise experimental research in which he had been taking a keen interest since his early youth. The discovery in this laboratory of the element hafnium by Coster and Hevesy was the result of a close collaboration between theoretical and experimental research as well as between physics and chemistry, which, in Bohr's theory of atomic structure, were for the first time founded upon common principles. As Bohr's theory united distinct branches of science, Bohr himself integrated in lectures at international congresses and at those carefully planned conferences in Copenhagen, the diverse scientific standpoints and epistemological attitudes of the physicists, and thereby imparted to all participants in those conferences the feeling of belonging, in spite of all their dissensions, to one large family."

In a letter to a colleague with whom he had correspondence on the desirability of re-establishing an ethical code for scientists, which was seriously disrupted in the period extending from the first to the second world war Einstein wrote, "It is really quite right that you intended the office of High Priest in this respect to be taken up by Bohr. For there is some hope that he might in this way distract the sacerdotal side of his soul from physics and use it otherwise".

We associate ourselves with the worldwide tribute paid to Prof. Bohr and we hope that he may long be spared to guide the Institute for theoretical physics in Copenhagen, which will become not only again the 'Capital of Atomic Physics' but also of the border land region of Physics, Biophysics, and Psychology where the principle of indeterminacy reigns.

TWENTY EIGHTH ANNIVERSARY MEETING OF THE BOSE INSTITUTE

The 28th anniversary meeting of the Bose Institute was celebrated on 30th November 1945, when the seventh Sir J. C. Bose Memorial Lecture on 'Induced Adaptability in Plants' was delivered by Dr P. Parija, Vice-Chancellor, Utkal University.

The Lecturer paid a warm tribute to Sir Jagadish Chandra Bose, the great Indian pioneer in scientific investigation, whose abiding interest in the study of plant response has greatly widened the bounds of our knowledge.

Turning to the subject of his lecture, he gave an account of the fine adaptations of plant organisms to their surroundings, how plants adjust themselves to dry situations, aquatic habit and so on. Examples of common plants such as mosses growing on walls, the water hyacinth, etc., were given as illustrations.

He then discussed the origin of these adaptations. Adaptations can be explained as the result of natural selection on variations or mutations. As to the origin of the variations or mutations, the lecturer favoured the view that these were brought about in response to external stimuli.

In support of this view, experiments on photoperiodism, vernalization and pretreatment were cited. By such treatment plants are made adaptable to con-

ditions under which they would not have otherwise grown.

Similarly treatment with X-rays and certain chemicals and heat treatments bring about heritable mutations such as polyploidy and gene mutations. Such mutations occur in nature and it is presumed that they must be originating in response to external stimuli. Once the variations are produced, natural selection would come into operations and the fittest, *i.e.*, the most adapted to the surroundings, would survive.*

After referring to the 50th anniversary of the communication of his first paper to the Asiatic Society of Bengal by Sir J. C. Bose (an account of which has already appeared in the December issue of SCIENCE AND CULTURE), the Director gave an account of the important plant physiological investigations of the Founder which were being followed up with improved technical appliances available now. The active substance discovered by Bose in the motor organs of sensitive plants has now been identified as crocin, which has been found in motile flagella of the alga *Chlamydomonas* by Kuhn in 1937. As predicted by Bose, this substance is an unsaturated carbon compound and belongs to the carotene group. The transmission of excitation due to stimulation in *Mimosa*, as investigated by Bose, and also his investigations on the ascent of sap in plants, both of which have given rise to controversies, are being continued by newer methods, including the use of radioactive trace elements.

Referring to other investigations carried out in the Institute, attention was drawn to the investigations which have been going on in the Institute for over two years, on the spontaneous fission of uranium nucleus, preliminary account of which were published last year in SCIENCE AND CULTURE. A great deal of interest has been recently attracted to the application of neutron induced fission of uranium, due to its utilization for the making of atomic bombs. If sufficient funds are made available, the Institute can undertake investigations on the industrial applications of the uranium fission process.

On the applied side investigations have been directed to the production of new varieties of jute with desirable economic properties by the irradiation of seeds with X-rays and neutrons. Favourable results have already been obtained. Similar investigations have been started with moulds and fungi of medical importance like *Penicillium* and yeast.

Retting of economic fibres like jute, coconut, hemp, flax etc., with enzyme complexes isolated from moulds and bacteria has been successfuly investigated. Samples of such enzymes have been supplied on request to the Ministry of Supply, England, for trial retting of flax. The process of bacterial retting has been tested under industrial conditions in a mill, for the processing of jute root-cuttings for the purpose of spinning and weaving of jute cloth. It has elicitated favourable reports both as regards the cost of the process and the strength of the cloth woven from them. Other investigations deal with the breeding of long stapled cotton suited for cultivation in Bengal, by selection and hybridization from pure strain seeds obtained from Coimbatore and Lyallpur.

Vernalization and photoperiodic treatment of Indian cereals like rice and wheat with a view to producing early ripening were continued successfully.

The Institute is receiving grants-in-aid from the Central Government, Bengal Government, B. S. I. R., Central Jute Committee, the Bengal Immunity Co. and the Raymas Corporation for investigations on nine different projects including those of cinchona, cotton, jute and medicinal yeast, construction of neutron and ultrasonic generators, and glass.

* We shall publish the text of the lecture in a future issue of SCIENCE AND CULTURE.

CONTROL OF ATOMIC ENERGY

The following extract of a letter from Dr Alexander King, British Empire Scientific Liaison Officer, Washington, to Sir S. S. Bhatnagar, which expresses the grave concern of the American scientists over the proposed domestic control of atomic energy, will be read with great interest:

"Scientists in the United States and particularly those who have worked on the atomic bomb and on certain other projects of great destructive potential are most concerned with the proposals, now before Congress, for the domestic control of atomic energy and are dismayed by the absence up to the present of any signs that the leaders of the American people are aware of the dangers inherent in the present situation. Accordingly, scientists engaged on these particular developments have organized themselves into groups to discuss how to impress on the people and its leaders the unprecedented gravity of the crisis in which humanity now finds itself; these local groups have not been organized by individuals with any particular political or sectional interest, but result from a spontaneous recognition of the responsibility which scientists have to bear in virtue of their superior knowledge of the realities of the situation.

"Groups of this type, formed at the Oak Ridge, Los Alamos, Chicago and New York atomic bomb laboratories, are already extremely vocal and active. At the Oak Ridge Research and Development Laboratory some 90% of the scientists appended their signatures to a preliminary "Statement of Intent",

and I am given to understand that this figure may be taken as representative of all the atomic bomb laboratories. A similar organization has sprung up at the Allegany Ballistics Laboratory and includes almost a hundred scientists, only three workers of the laboratory being unwilling to sign a statement of opinion. In addition, other groups of scientists not engaged on researches of military importance, but holding the same views, are springing into existence.

"At an informal meeting held this week between representatives of the Allegany and Oak Ridge groups, discussions took place on how to form a national and, if possible, an international association of scientists for the purpose of bringing to the attention of all governments the necessity of placing atomic energy developments exclusively in the hands of a World Organization. It emerged from the conversation that both groups were acting from the same motives—fear of the immediate physical consequence of an armaments race in the atomic age, fear of the destruction of civilization and of the best fruits of the human spirit, fear that science might be shackled by security and other regulations and enfeebled by its prostitution to nationalistic military ends.

"It should be realized that these views in the United States are not confined to the younger scientists; on the contrary the elder statesmen of science such as Einstein, Bush, Arthur and Karl Compton, Franck, Urey and many others have specifically expressed their belief that scientific knowledge must be free and that atomic energy developments should be made the monopoly of some World Organization created for the purpose and possessing inspection and police powers over the whole earth. Being acutely aware of the urgency of the situation, the American groups feel that scientists must now and henceforth take a lead in these matters, and I have been asked to make informal approach to a few scientists in other countries to ascertain their opinions on the international control of atomic power and of the necessity or otherwise for preserving the freedom of science."

DECIMAL SYSTEM FOR GREAT BRITAIN

In a letter recently addressed to the secretary of the Indian Decimal Society, Calcutta, which has been communicated to us, Mr Harry Allcock, chairman of the Council of Decimal Association, director of the Manchester Chamber of Commerce and vice-president of the Federation of British Industries, has drawn attention to a movement that has been set a foot in Great Britain for decimalization of coinage, weights and measures. On the 12th October last, a conference was held under the auspices of the Manchester Chamber of Commerce, at which over 100 chambers were represented. The resolution which was adopted by a very large majority ran as follows:

"Having regard to the vital national importance of export trade expansion and to the consequential need for the improvement of our trading methods by all available means, the Association of British Chambers of Commerce considers it essential that British traders should employ a decimal system of coinage and the metric system of weights and measures, of which the higher efficiency, as compared with the British systems, has been so amply demonstrated in so many countries for so many years. In view of the technical nature of these proposals, it is suggested that the Government should set up an appropriate committee (or committees) to recommend the most convenient means of securing the desired objects."

It is further stated that the International Chamber of Commerce has officially recommended that all systems of weights and measures other than the Metric System be abandoned. Similarly the International Business Conference at Rye, New York, attended by representatives of 52 nations resolved that

"there should be adopted for use in international trade a single system of weights and measures—preferably the Metric System."

These developments lend further strength and justification to the decimalization of Indian coinage, weights and measures, for which a movement has already been started in India. A quicker decision on the part of the Government and the industry in favour of decimalization is urgently needed now that problems of reconstruction are coming up for consideration before the nation.

FERTILIZER PLANT AT ALWAYE

Reference to a fertilizer plant at Alwaye in Travancore State, then under construction, was made in an article in SCIENCE AND CULTURE, (December, 1944), in which details of location, plant, and method to be adopted in the synthesis of ammonium sulphate appeared. The completion of the administrative block of the Fertilizers and Chemical Factory is now reported, and on December 1, 1945, H. H. the Elayaraja of Travancore formally inaugurated the block before a large and distinguished gathering.

The completed work, comprising the administrative block, buildings including housing colony, workshops and stores, and office buildings occupying a total covered space of nearly 300,000 square feet in an ideally located site of over 200 acres, represents the first stage in the construction work. The project, estimated at Rs. 2¼ crores, contemplates the manu-

facture of 50,000 tons of ammonium sulphate fertilizer annually. The plant is expected to start production of the synthetic fertilizer by July 1946. The project also includes manufacture of many useful chemicals such as sulphuric acid, caustic soda and other products essential for national economy and self-sufficiency.

THE UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION

The United Nations Food Conference which recently met at Quebec decided to create the Food and Agriculture Organization (F.A.O.) which would endeavour to secure freedom from want to all people irrespective of race and colour. Representatives of thirty countries, including India, attended the conference and signed the constitution of the organization. Representatives from Soviet Russia took part in the proceedings of the various committees and panels of the conference, but did not sign the constitution, as their Government felt they had to consult some of their constituent Republic and examine in further details the organization forces of the F.A.O.

The main purpose of the organization is to consolidate peace by fostering food production, by increasingly utilizing technical knowledge for the benefit of agriculture and by rendering immediate relief to the people of the war-devastated areas. The F.A.O. will undertake a complete world survey of production, consumption and international trade in the major agricultural products, so that information about surpluses is made available and international trade regulated. F.A.O. will also undertake comparative studies of the world's food needs and make arrangements for diverting surpluses to areas which are suffering from nutritional deficiency. A world census in 1950 is proposed with the object of collecting data on the world food and agriculture conditions and thus preparing a World Food Plan. The results of scientific research will be compiled and made available to member countries through a bibliographic service.

F.A.O. will also maintain panels of technical experts and will send missions to countries which would desire their services. In co-operation with the International Bank of Reconstruction and Development, it proposes to render help to less developed countries in the field of credit.

F.A.O. will not be a centralized body like the old League of Nations but will have regional offices through which it will maintain intimate contacts with the peoples and problems of different countries. It is likely that India too will have a regional office. It has been decided that the personnel of F.A.O. will be international in character and representative of the various geographical regions. Vacancies will be widely advertized and selection will be made by the Director-General on a competitive basis. The seat of F.A.O. will be at the same place as the head-quarters of the United Nations Organization. For the time being it will be located at Washington.

Sir John Boyd Orr has been appointed the first Director-General of the F.A.O. He observed that the time had come when tanks were turned into tractors and factories which manufactured explosives were converted to produce fertilizers and humanity entered an era of peace and plenty. The delegates of all countries unanimously maintained that unemployment, poverty and hunger were the basic causes of war and strongly advocated that slump in the prices of agricultural commodities like the one the world experienced in 1930 must be prevented and the producer of such commodities guaranteed a fair and equitable price.

Sir Girja Shankar Bajpai led the Indian Delegation. He presided over the Committee on constitutional and diplomatic questions which dealt with such important topics as the taking over of the International Institute of Agriculture, Rome, and admission of new members. Mr D. R. Sethi presided over the Panel on Special Needs for Countries in Tropical and Sub-Tropical Regions, which was particularly important from the Indian angle. Dr V. K. R. V. Rao served as rapporteur to the Statistics Committee, while Dr Aykroyd and Sir Herbert Howard served as rapporteurs of Nutrition and Food Management Committee and the Forest Products and Rural Welfare Sub-Committee respectively.

ECONOMIC DEVELOPMENT OF CHINA

China, like India, is a poor agricultural country, with little or no development of industries, and has for long offered an attractive market to Western manufacturers which have sucked the country dry of her wealth. Eight years of war and of indescribable sufferings have brought a new consciousness among the Chinese people—a determination to live as a vigorous and prosperous nation through a balanced development of industry and agriculture. Possibilities and problems of industrializing China are now being widely discussed in China, and our attention has been recently drawn to a ten-billion dollar plan of industrial development, worked out by Mr K. Y. Chen, Assistant Chief, Far Eastern Division, U.N.R.R.A. (*Mechanical Engineering*, June, 1945).

It is in the first instance a five-year plan in which development of transportation and communication, public health and utility, coal mines and iron works, manufacture of consumer goods and farm goods

plants such as fertilizers, insecticides, etc. have been recommended.

Great emphasis has been placed on the development of transportation and communication which would alone account for $5,200,000,000 or 52 per cent of the total estimated cost. The plan envisages expansion of the railway by 20,000 miles, of the highways by 150,000 miles, of the shipping tonnage by 5,000,000 tons, of motor-cars by 500,000 units, and development of tele-communication, air-lines and air-plane factories.

The utter inadequacy in public utility services and health measures has been recognized. In 1944, China had only 38,834 hospital beds, and the plan proposes to add another 90,000 beds so as to make provision for at least one bed for every 5,000 people. Hospitals of the United States, be it noted, provide one bed for each 90 people. Under public utility, the plan suggests development of hydro-electric power to the extent of 10,000,000 kw. Developments in public utility and health, according to Mr Chen, would involve an expenditure of $1,700,000,000.

Industries producing consumer goods have hardly developed in China. The country can supply only one quarter of the requirements of clothing on a basis of 10 sq. yds. per year *per capita* from her own spindles, to cite one instance. Flour mills (75,000 tons per day), rice mills (375,000 tons per day), spindles, building-material plants, such as cement, brick, saw-mills, glass, paint, etc., and plants and machinery required in the manufacture of sugar, soap, oil and paper are some of the items whose development and expansion have been urged. A provision of $1,112,500,000 is indicated in the plan for the establishment of these industries.

A sum of 500 million dollars has been set apart for development of agriculture, including improved methods of cultivation, increased use of fertilizers, better seeds and insecticides. Establishment of fertilizer plants has been suggested.

Fuel and iron constitute the background of any industrial development. Mr Chen proposes to reserve $1,500,000,000 for the development of coal mines and iron works.

The required money for financing such a five-year economic plan of development would be available, according to Mr Chen, partly from foreign exchange and partly from national saving. China's annual foreign exchange has been estimated at $610,766,000, which is supposed to be enough to service a capital of $8·7 billions at an annual interest of 3 per cent and an amortization of 4 per cent. Internal expense comprising the cost of local material and labour for such a plan may be roughly taken to be 40 per cent of the total expenditure. On this calculation, annual internal expense works out to $1,300,000,000, and Mr Chen hopes that this sum can be realized from national saving.

HEAVY INDUSTRIES IN PROVINCES

The All-India Manufacturers' Organization has just issued a pamphlet entitled "Development of Heavy Industries in Provinces" containing proposals, compiled by Sir M. Visvesvaraya, president of the Organization, for the establishment of two new key and heavy industries in each of the eleven provinces of British India. The twenty-four typical heavy industries listed in the pamphlet, from which two will have to be chosen for each province, include: Internal Combustion Engines and Power Machinery; Manufacture of Machinery and Plant; Railway Machinery and Plant; Electrical Machinery; Hydro-Electric Plant; Mill Machinery; Agricultural Machinery and Tools; Manufacture of Machine Tools; Shipping and Ship-building; Locomotives; Automobile; Aeroplane; Mining; Increased production of Steel and Coal; Structural Steel—Machinery, Engineering Industries; Non-Ferrous Metals; Aluminium; Selected Chemical Industries—Sulphuric Acid, Caustic Soda, Soda Ash, Sodium Carbonate, Chlorine, etc.; Fertilizers; Dyestuffs; Rayon; Paper and Pulp; Plastics; Cement; Glass and Porcelain Ware.

Some provinces, placed more favourably with regard to the supply of raw materials and other needed facilities, may establish more than two industries, such that all the 24 industries may be eventually brought into existence. A committee of the organization, as a result of its communications with the leaders and businessmen in the various provinces, collected useful facts regarding the suitability of particular industries for each provinces. These investigation and a provisional list prepared on their basis, from which to select two new heavy industries, have been indicated in a compact table at the end of the pamphlet.

The capital cost involved in the establishment of the 24 heavy industries has been estimated at about Rs. 100 crores, on the assumption that the capital cost of two heavy industries for every province would amount to between Rs. 3½ and Rs. 5 crores.

The pamphlet has recognized the great importance of proper provision for equipment and technical education and has recommended manufacture of machines and defence machinery, and the establishment of, an institute of technology on the model of the Massachusetts Institute of Technology, firms of consulting engineers, industrial finance corporation, and an industrial journal. Regarding the training of technical personnel, the Government

measure to depute students for overseas training has been criticized as too slow a process. The pamphlet recommends training of local technicians by experts invited from England, America, Sweden, Czechoslovakia or such other countries which can spare them.

In such a drive for industrialization, the Government have an obvious responsibility and an important role to play. The plan suggests that the Government should forthwith create (1) a Central Department of Industries under an independent full-time minister, or Member of the Central Government, and (2) an Economic or Industrial Council to represent the people's views and wants and to work in co-operation with the Department. Further, the Government have been urged to introduce an elaborate arrangement for the speedy collection of statistics, institute an annual grant of not less than Rs. 6 crores for equipment, research, investigation, subsidies, subventions, etc., give assurance of protection in suitable cases before some manufacture is undertaken, enforce a policy of strict conservation of high grade coal for use in industry, and adopt a policy of the fullest encouragement of the indigenous production of iron and steel.

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

We are glad to learn that a new research institute under the name Tata Institute of Fundamental Research, has been opened at 49-53, Pedder Road, Bombay by His Excellency the Rt. Hon'ble Sir John Colville, Governor of Bombay. The Director of the institute is Prof H. J. Bhabha, F.R.S., who has acquired an international reputation by his outstanding contributions to the theory of Cosmic Rays and of fundamental particles. The idea of such an institute is quite new in India and it reminds one of the Institute of Fundamental Research in Moscow, which was built by the Russian Government for Prof P. Kapitza. The institute here is not built for a specific purpose, but built round a man who has made outstanding contributions to particular subject in order to enable him to develop his thoughts and create a school of active research.

We hope that streams of works on fundamental researches in physics and other sciences would continue to flow from the institute and it will prove to be a nursing ground for the development of young Indian genius.

ALL-INDIA COUNCIL FOR TECHNICAL EDUCATION

In pursuance of the recommendation of the Central Advisory Board of Education for a Central Organization for the promotion of higher stages of technical education, the Government of India have constituted an All-India Council for Technical Education, with Mr N. R. Sarkar as its Chairman. The task of the Council will be:

(*a*) to survey the whole field of technical education in consultation with the Provincial Governments and such Indian States as may be willing to co-operate with it;

(*b*) to advise in what areas technical institutions should be established, for what respective branches of technology they should provide and up to what standards they should co-operate;

(*c*) to consider such projects as are already under consideration by various Departments of the Government of India, *e.g.*, the provision of senior all-India polytechnics on the lines of the Massachusetts Institute of Technology or the establishment of a technical college for electrical (power) engineering, and to assign their functions in an all-India scheme; and

(*d*) to conduct preliminary investigations with a view to ascertaining the conditions on which the authorities in control of the existing technical institutes would be prepared to co-operate.

The Council will be composed of Chairman; Educational Adviser to the Government of India; representatives of the Departments of the Government of India; one member of the Council of State elected by it; two members of the Legislative Assembly elected by it; one representative of each Provincial Government; five representatives of Indian States to be nominated by the Governor-General in consultation with the Crown Representative; fourteen representatives of industry, commerce and labour to be nominated by the Associated Chambers of Commerce, All-India Organization of Industrial Employers, Federation of Indian Chambers of Commerce, Federation of Muslim Chamber of Commerce and Industry (Delhi), Employers' Federation of India, All-India Trade Union Congress, Indian Federation of Labour and All-India Railwaymen's Federation; two members of the Central Advisory Board of Education; two members of the Inter-University Board to be nominated by the Board; two representatives of the Association of Principals of Technical Institutions in India; one representative of the Institution of Engineers; and two nominees of the Government of India to represent any other interest which they may consider desirable.

The names of members will be announced after the representatives of the Council of State and the Legislative Assembly have been elected in the next session of the Central Legislature. The tenure of office of the non-official members including the Chairman will be three years. The Council will be attached to the Department of Education, Government of

India. A member of the staff of the Department will be the Secretary of the Council.

To those who follow intelligently and critically the methods of the Government of India, the above communique will hardly evoke any hope or satisfaction. The state of higher technical education in this country has been deplorable for a long time, and the Industrial Commission appointed at the close of the last war recommended the establishment of an Imperial College of Science and Technology. The recommendation was still-born, and no action has been taken on it for the last twenty-five years.

The personnel of the new Council will hardly inspire any confidence. The members selected to serve on the Council are mostly men prominent in business, industry, or otherwise and have little qualification for serving in such a Council which should be composed of educationists, scientists and technicians. Further the members of the Council ought to be full time workers as long as they serve on the Council. Moreover, the members are such big persons that they can hardly be expected to spare much time and leisure. As the Council is constituted, probably the members will meet for one or two days for a few hours, discuss some vague generalizations and leave to the secretary the entire responsibility of drafting the recommendations which will be hardly worth reading.

The antiquated procedure which is still followed in this country should now be definitely given up if any business is meant. As in England and America, the Government should appoint a whole time committee of experienced educationists and scientists, to whom the working, organization, and purpose of such institutes are not a mere blank but are realities with which they are already acquainted. They should not be released till they have submitted a full report, and action should immediately be taken on the report.

But probably such an action will not appeal to the Government accustomed to make large promises, and when nothing materializes, to make amends by vague excuses. Further such action will not help 'empty headed persons' to qualify for future ministerships.

OVERSEAS SCHOLARSHIPS FOR STUDIES IN TOBACCO

THE Imperial Tobacco Co. of India Ltd., has instituted two studentships of the value of £500 each, tenable for two years, to Indian students for studies abroad in Agriculture with special reference to tobacco. The Company has left the studentships to the administration of the Indian Central Tobacco Committee constituted by the Government of India. Pending the formal registration of this Committee, the Imperial Council of Agricultural Research has accepted the Company's generous offer and the Government of India have agreed to assist in placing the students in suitable institutions abroad. Arrangements for the selection of students are now in hand and it is hoped that they will proceed abroad as soon as the necessary facilities have been secured. The places of study will probably be in the U.S.A.

NEW JUTE DIRECTOR

Prof B. C. Kundu, M.A., Ph.D., F.L.S., F.N.I., Professor of Botany, Presidency College, Calcutta is appointed Director, Jute Agricultural Research, in charge of the Agricultural Research Laboratories, of the Indian Central Jute Committee, at Dacca.

Prof Kundu had a brilliant academic career, and obtained a first class Master's degree in Botany of the Calcutta University in 1927, standing first in order of merit. After a short period of service as a lecturer in Botany, Ravenshaw College, Cuttack, Dr Kundu took to research work in Botany in the Calcutta University under Prof S. P. Agharkar, on being awarded Sir Rash Behary Ghosh Research Scholarship, where he worked on 'Charophyta of Bengal' (*Jour. Dep. Sc. N.S. C.U.*, Vol. 1). He served as a lecturer in Botany, Rajshahi College, Bengal from 1930 to 1937. In the latter year he proceeded to England on study leave, and worked under late Prof. J. B. Priestley of the Leeds University, on the fibre plants of India with special reference to their development, growth and structure. In collaboration with Dr R. D. Preston, F.R.S., he worked on the fine structure of the fibres of hemp and jute (*Proc. Roy. Soc., London*).

While in England, Dr Kundu had also opportunities of working in the Royal Botanic Gardens, Kew and in the British Museum, London and published papers on the revision of the Indian species of *Hodgsonia* and *Trichosanthes*.

He has been serving as a Professor of Botany, Presidency College, Calcutta and an Honorary Lecturer in the Calcutta University, since 1939. During these years he has been working on jute, sunn hemp, *hibiscus* and other fibre-yielding plants and has published a number of papers on these in various journals. He had undertaken work on the 'Growth and Development of Jute Fibres', financed by the I.C.J.C. and on the anatomy of *Brassica* and *Sesamum* financed by the I.C.A.R.

As Honorary Secretary of the Botanical Society of Bengal, he showed commendable power of organization.

Dr Kundu has a wide outlook of his subject, has taught a variety of subjects pertaining to different

aspects of Botany, and has guided a number of research scholars working under him, and we feel sure that he will be able to organize and administer the department, the duties of which he has just taken charge of.

NEW FELLOWS OF THE NATIONAL INSTITUTE OF SCIENCES, INDIA

At a meeting of the Council of the National Institute of Sciences of India, held on Monday, the 19th November, 1945, at the Delhi University, Delhi, the following gentlemen were declared to have been elected Fellows of the Institute:

Ordinary Fellows

Dr I. Banerji, D.Sc., Lecturer in Botany, Calcutta University; Dr P. B. Ganguly, D.Sc., Principal, Science College, Patna; Dr S. Ghosh, D.Sc., Professor of Chemistry, School of Tropical Medicine, Calcutta; Dr P. S. Gill, Ph.D., Professor, Forman Christian College, Lahore; Dr J. C. Gupta, M.B., Professor of Pharmacology, School of Tropical Medicine, Calcutta; Dr S. S. Joshi, D.Sc., Principal, College of Science, Benares Hindu University; Dr B. C. Kundu, Ph.D., F.L.S., Professor of Botany, Presidency College, Calcutta; Dr C. Mahadevan, D.Sc., Assistant Superintendent, Hyderabad Geological Survey, Hyderabad-Deccan; Dr P. C. Mahanti, D.Sc., F.Inst. P., Lecturer in Applied Physics, Calcutta University; Dr U. S. Nayar, M.A., Ph.D., Head of the Department of Statistics, Travancore University, Trivandrum; Dr N. V. Radhakrishna Rao, M.B., B.S., Ph.D., Clinical Research Officer, Haffkine Institute, Parel, Bombay; Dr M. L. Roonwal, Ph.D., Assistant Superintendent, Zoological Survey of India, Benares Cantt.; Dr H. E. M. Wheeler, D.Litt., Hon. D.Litt., Director-General of Archaeology in India, Simla.

Honorary Fellows

Prof A. F. Blakeslee, Smith College, Northampton, U.S.A.; Dr R. A. Millikan, President of the California Institute of Technology; Prof P. Niggli, Professor of Mineralogy and Petrology, Federal Polytechnical University and University of Zurich.

ANNOUNCEMENT

Dr U. N. Chatterji, M.Sc., D.Phil., officiating Editor of Journals, Imperial Council of Agricultural Research, New Delhi, has been admitted to the degree of Doctor of Science of the University of Allahabad. The subject of his thesis was "Physiological Studies on Some Intermediate Steps in Plant Respiration".

SCIENCE IN INDUSTRY

ANTHRAQUINONE STABILIZER FOR PAPER CAPACITORS

Great stabilization of paper capacitors, resulting from the adding of a small amount of anthraquinone to the impregnant, has been reported in an article by D. A. McLean (*Bell Lab. Rec.*, *23*, No. 3; March, 1945), abstracted in *Nature*, October 13, 1945. Paper insulated capacitors are treated with impregnants, such as chlorinated diphenyl and chlorinated naphalene, which have high dielectric constant and resist oxidation and thermal decomposition fairly satisfactorily at room temperature and at small potentials. The dielectric properties, however, show rapid deterioration at high D. C. potentials and at temperatures from 50°C to 100°C. Suppression of deterioration of the dielectric, corrosion of the electrodes, a more stable leakage current, and consequently a longer life have been effected through the use, in small quantities, of a number of chemical compounds, of which the quinones give the most satisfactory results. For commercial use, anthraquinone has been recommended owing to its high effectiveness, ready availability in pure form, low volatility and lack of toxicity.

The stabilizing effect of anthraquinone in reducing electrode corrosion has been very clearly brought out in the following experiment. Thin aluminium films were evaporated on kraft paper, and capacitors made with such paper were dried and impregnated in the usual manner. After subjecting the capacitors at high voltage and at temperature 100°C, the impregnating compounds were extracted and portions of the paper photographed to reveal holes due to corrosion. After testing for 240 hours at 300 volts, the anode was found very largely destroyed, and eventually the cathode was also attacked. The samples stabilized with anthraquinone and tested under the same conditions did not show detectable deterioration of either electrode in 1,000 hours, or in 495 hours at 500 volts.

In unstabilized linen-paper capacitor subjected to a continuous D.C. voltage at 100°C, leakage current becomes formidable and causes failure within a few hours. Use of anthraquinone to the extent of 0·1 per cent with the impregnant effects a more steady leakage and increases the life by about ten-fold. By using the stabilizer to the extent of ·5 to 9 per cent, a hundred-fold increase in life compared to the unstabilized variety has been reported.

IMPREGNATED WOODS IN AUSTRALIA

The Division of Forest Products of the Council for Scientific and Industrial Research at Melbourne and a number of Australian firms have recently developed several improved woods for commercial purposes, such as manufacture of propeller blades, variable pitch airscrews, ball and roller bearings, gear wheels, brake linings, pulleys, shuttles and bobbins in the textile industry, fish plates for electric railways, mounting panels, terminal boards and insulating stools for the electrical industry, etc.

Well known Australian timbers, such as mountain ash, coachwood, hoop-pine and Kauri-pine, have been treated successfully, the veneers being coated with a synthetic resin and then compressed and bonded at high temperature and pressures. Improved woods produced in this way show a remarkable resistance to moisture. Scientifically bonded laminated veneers have also been found comparable to duralumin in certain mechanical properties, and their manufacture has been carried out in England and America for several years.

The Laminex Pty. Ltd., at Brighton, in the State of Victoria which has installed the largest laminating press in Australia, has developed several improved woods, suitable for panelling, furniture, and decorative fixture work, by a combination of the processes of impregnation and the bonding of the veneers with Tago glue film.

By impregnating layers of special cloth or paper with a synthetic resin in a way similar to the treatment of wood, some Australian firms are reported to have developed special types of plastics materials highly suitable for the manufacture of insulating sheet, aircraft cases, engine parts and pre-fabricated houses.

STARCH STORAGE IN THE BARLEY GRAIN

Recent investigations dealing with the sugars of the barley plant cast doubt upon the hypothesis that the stored sugar of the stem is a reserve for maintaining the growth and development of the fruit. If it is accepted that this sugar is lost as part of the inevitable senescence of the stem itself, then the function of the accumulated sugar in sugarcane and in other monocotyledonous stem needs reconsideration. In carrot or sugar beet, it is known that the separated crown can produce flower even if it is deprived of the stored carbohydrate. Similarly the reserves of inulin in artichoke and starch in potato is not essential for successful regeneration. The amount of carbon involved in shoot formation is small in relation to the total carbohydrate reserve and similar conclusion holds good for the barley stem that sugar is produced in excess of immediate growth requirements and becomes isolated in parenchymatous tissue, from which it disappears slowly with the senescence of the 'storage' organ.

These facts are briefly summarized in an article by Archbold in *Nature*, July 21, 1945. The earlier workers held the view that the excess of stored carbohydrate in the stem of cereals was translocated in the fruit and efficient migration followed high ratios (*i.e.*, ratio of grain to total top or 'migration ratio').

If any function is to be attributed to the sugar in the shooting stem of cereal it may perhaps be concerned with maintenance of *turgor* in the rapidly elongating cells.

Archbold and Mukherji (*Ann. Bot.* N. S., *6*, 1942) by suitable experiments noted that at no time did the roots provide material for upward translocation. Major changes during ear development were confined to the stems and leaves. Only 20 per cent of the sugars in stem and leaves were transferred to the ear, remaining 80 per cent was supplied by assimilation proceeding simultaneously with ear growth. The stored sugar in stem is thus only of secondary importance as a source of supply to the ear.

Archbold and Datta (*Ann. Bot.* N. S., *8*, 1944), conducted a series of experiments to investigate the factors controlling sugar movement and concluded that only very limited diversion to the ear of sugar newly assimilated in the leaves is possible.

GEOPHYSICAL PROSPECTING FOR OIL IN INDIA

Rankine and Evans referred briefly to the origin and accumulation of oil, and indicated the scope of geo-physical methods in a paper communicated to the National Institute of Sciences of India at a meeting held recently at Delhi and briefly reported in an earlier issue of the journal. A few typical gravimeters are described, the principles of reflection and refraction surveys are summarized and the scope of the electrical surveys is outlined. The principal geophysical methods of survey are thus conveniently classified as (1) Gravitational, (2) Seismic, (3) Electrical, and (4) Magnetic.

The history of geophysical prospecting for oil in India is set out in some detail, with the scope and cost of the 1938-40 prospecting programme. The first Indian prospecting by geophysical methods was undertaken in 1923, and in the following year the first oil field discovery by torsion balance method was made in America.

Surveys carried out by the Burmah Oil Company showed that torsion balance could readily detect buried thrust-faults but they did not lead to the discovery of any area worth drilling. Later in 1938, a seismic survey was undertaken in the anti-clinical area in Assam, but the result was also unsuccessful.

Extensive geophysical surveys were carried out in 1938, with 17 separate parties and the total strength of geophysicists, surveyors, observers and other technical personnel was 90. They worked in close co-operation with the Geodetic branch of the Survey of India, but this work had to be closed down in 1939 owing to the war.

During a period of two and a half years, geophysical observations were made at more than 22,000 stations (two-third of these being in British India). The total area surveyed amounted to about 330,000 sq. miles, involving a total cost of 45 lakhs of rupees.

As soon as seismic work can be resumed, it is proposed to try refraction arc shooting in India. There is necessity for a unified prospecting programme in which geological mapping, geophysical surveys, of alluvial areas, and the drilling of information holes and test wells are all closely co-ordinated.

FRENCH CHEMICAL INDUSTRY

RECENT progress in chemical industries in France, including development of new adhesives, improvement in fertilizers, and exploration of uranium deposits, has been reported in the *Chemical Age*. A new adhesive preparation which glues rubber to metal has been developed. A synthetic resin, easily soluble in ordinary rubber solvents is prepared by heating phenolsulphonic acid over crude rubber to 135°C. The solution can be stretched over a metallic surface so that vulcanized mixtures can be super-imposed. The adhesive is very thermoplastic and becomes soft at 70°C, even after vulcanization.

Increased supply of coal, sulphur, phosphates, potash, and Thomas slag, some of which are now available even for export, has brought about a great increase in the production of fertilizers. Latest production figure which appeared in print was 13,000 tons a month for concentrated fertilizers. In July, the production of super-phosphates was 7,000 tons. Two plants for the concentration of crude potash salts from the Alsatian mines resumed operations on July 15, but it will be necessary for the next year or two to ship fertilizer potash mainly in the form of crude salt.

Progress in other industrial chemical products was also noticed. In July, monthly production of a number of important chemicals was as follows: sulphur, 10,000 tons; sulphuric acid, 15,800 tons; copper sulphate, 4,000 tons; soda, 7500 tons; calcium carbide, 12,000 tons; and tannin extract, 837 tons.

The quarries of Saint Gobain, long known for their deposits of radio-active minerals, are now receiving great attention as possible source of uranium, the important material for the manufacture of atomic bombs. In 1904, the Curies extracted uranium from deposits of pitchblende at Coulard à Auxy and at Crury. The Saint Gobain glass works once used this mineral extensively for tainting purposes.

The French chemical industry is now very actively engaged in regaining its lost position and is looking forward to occupying the place of supremacy formerly held by Germany.

RETTING BY HIPAROL AND BY BACTERIA

PARUKUTTY BARUAH AND H. K. BARUAH

MICROBIOLOGY DEPARTMENT, BOSE RESEARCH INSTITUTE, CALCUTTA

BARUAH and BARUAH (1914) have shown that Hiparol, a mixture of enzymes extracted from *Thielaviopsis paradoxa* (De Seynes) V. Hohn, can ret jute, coconut and other fibrous plants in a much shorter time than that is required in the normal process of stacking plants in water. The delay in the latter process, *i.e.*, by stacking plants in water and allowing bacteria to decompose the plants, may be due to the slow growth of bacteria or of insufficient amounts of enzymes produced on the plant tissues. The reason is that the production of pectinases by bacteria is not only influenced by the rate of growth of bacteria on the plant tissues but also by the chemical nature of the substrate influencing the formation of enzymes capable of breaking down tissues. Methods using fungi, bacteria and chemicals to reduce the time required for retting and to improve the quality of the fibres had always, therefore, been looked for, and any method that reduces the time required for retting without impairing the quality and tensile strength of the fibres would be of advantage to the growers and to the fibre industry as a whole.

Rossii (1916) has described the use of *Bac. Comesii* in retting of hemp and flax by maintaining a temperature of 28°—30°C and forcing air through the culture fluid. Aerobic processes using *Clostridium butyricum* and *Clostridium felsineum* had also been tried and patented, but none of these processes had been used on a commercial scale on jute, coconut and other fibrous plants. This may obviously be due to the practical difficulties involved in the application of these methods to the retting of cheap fibres like jute and coconut. If, however, bacteria responsible for retttng are isolated from plants stacked in water and cultured according to methods described by Baruah (1942) and added to water in which fibrous plants are stacked, it is possible to enrich the water by the particular bacteria concerned and also by the bacterial enzymes produced in culture and thus hasten the separation of the fibre bundles from the cortex and wood.

The present paper deals with determination of the activity of bacterial enzymes and a comparative study of the rates of activities of Hiparol and bacterial enzymes and of their uses in retting. Methods used for the determination of activities of bacteria and bacterial enzymes were the same as those used in determination of activities of Hiparol by Baruah and Baruah (1944). *Bacillus sp.* isolated from decomposed and semi-decomposed jute plants was cultured on bran at 33°C: bran was dried and stored in bottles. Enzyme extracts of *Thielaviopsis paradoxa* (Hiparol) and Bacteria were obtained by the methods used by Baruah (1942). Pectinase and lamellase activities of bacteria were determined by the rate of maceration of blocks of plant-tissue, rate of decomposition of pectin and by the rate of softening of the fibrous tissues. Table I shows the time required for maceration of blocks of plant-tissue by Hiparol and by bacteria at *p*H 5·0 and at 28-30°C. Controls were set up by using boiled enzyme extracts.

TABLE I

TIME OF MACERATION OF BLOCKS OF PLANT-TISSUES
Temp. 28 -30°C.

Type of plant-tissue	Time required for maceration of blocks of plant-tissues		Control after boiling	
	Hiparol	Bacterial enzyme	Hiparol	Bacterial enzymes
Mango	20 Minutes	10- 18 hours	No action	Action after 24 48 hrs
Apple	20 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Pineapple	20 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Grapes	20 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Orange rind	25 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Lemon rind	40 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Tomato	25 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Banana	25 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Guava	35 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Pumpkin	42 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Jute-stem	8—10 hrs.	48—72 ,,	,, ,,	,, ,, ,, ,, ,,
Ramie stem	8—12 ,,	,, ,, ,,	,, ,,	,, ,, ,, ,, ,,
Green Coconut husk	42 Minutes	18- 24 ,,	,, ,,	,, ,, ,, ,, ,,
Dry Coconut husk	42 hrs.	36—48 ,,	,, ,,	,, ,, ,, ,, ,,

Bacterial enzymes macerated plant-tissues completely within 10-72 hours and there was a vigorous colony of bacteria growing on the tissues, whereas Hiparol completely macerated the plant-tissues, including jute, within the first few hours. Lamellase which caused loss of coherence of the tissues (Baruah, 1942) may not be actively present in the bacterial extracts as it is in Hiparol, but bacteria, while growing, secrete lamellase which is responsible for the breakdown of tissues. It is, of course, possible to increase the production of lamellase by bacteria by changing the composition of the substrate (Baruah, 1942). Heat inactivates the enzymes in Hiparol, whereas with bacteria heat applied, as in Hiparol, was not sufficient to kill the bacterial spores which, during 24 hours of incubation, grew vigorously and caused breakdown of the tissues.

The rate of decomposition of citrus pectin by Hiparol and by bacterial enzymes has been followed by studying the changes in the viscosity of pectin solution, changes in the reducing power and in the saponification value of pectins during hydrolysis (Table II). The reaction-mixtures were composed of 100 c.c. of 1% pectin solution of *p*H 5·0 plus 20 c.c. of 2% Hiparol or 2% bacterial enzyme extract and were incubated at 28-30°C.

was a decrease in the saponification value of pectin during hydrolysis with Hiparol as well as with bacteria, indicating thereby the changes in the degree of demethylation during hydrolysis.

It thus appears that the breakdown of pectin, both by Hiparol and by bacteria and bacterial enzymes, is accompanied by a rapid decrease in viscosity and in the saponification value of pectin and by an increase in the reducing power of pectin. Hiparol macerates plant tissues rapidly, whereas there is little lamellase action in the bacterial extract, the breakdown at a later stage being affected by the growing bacteria producing lamellase (details to be published later).

Use of Hiparol and Bacteria and Bacterial Enzymes in Retting

Table III shows the time required for retting of jute, coconut and other fibrous plant tissues by Hiparol and by bacteria and bacterial enzymes. The method was the same as used before (Baruah and Baruah, 1944).

The husks from ramie, gerardinia, mauotia and coconut were retted in 1-3 days by bacteria, whereas

TABLE II

Changes in Pectin caused by Hiparol and Bacteria

Temp. 28–30°C.

Time in Hours	Relative Viscosity		Amount of undecomposed Pectin		Amount of reducing Sugar as dextrose Iodine reaction		Saponification value as gms. of NaOH per 100 gms. of dry ash-free Pectin	
	Hiparol	Bacteria	Hiparol	Bacteria	Hiparol	Bacteria	Hiparol	Bacteria
0	100	100	1·0 gms.	1·0 gms.	2·5%	2·5 %	9·6 gms.	9·6 gm
3	41·3	32·5	0·56 ,,	0·54 ,,	4·9%	23·64%	8·9 ,,	8·088 ,
24	7·8	0	0·42 ,,	0·44 ,,	6·2%	32 %	6·46 ,,	6·036 ,
48	3·9	0	0·36 ,,	0 ,,	31·5%	28·8 %	5·0 ,,	...

The decomposition of pectin was more rapid with bacterial enzymes than with Hiparol, relative viscosity of pectin being reduced by bacteria to 32·5% after 3 hours and to 0% after 24 hours. The increase in the amount of reducing sugar formed was more rapid with bacterial enzymes than with Hiparol within the first 24 hours, after which there was a decrease probably caused by the utilization of reducing sugar by the growing bacteria. With Hiparol, there was an increase in the amount of reducing sugar up to 31·5%, after which the reducing sugar value was almost constant (Baruah and Baruah, 1944). With bacteria, there was no precipitable pectin on the addition of acid alcohol after 48 hours. There

TABLE III

Time required for retting by Hiparol and by Bacteria

Type of Plant-Tissues	Hiparol	Bacterial Enzymes
Crotolaria ...	3 – 4 days	3— 5 days
Ramie (Chinagras)*	28—48 hrs.	24—48 hrs.
Gerardinia ...	24— ,,	24—48 ,,
Mauotia ...	24—72 ,,	24—96 ,,
Jute ...	18—24 ,,	3— 7 days
Coconut husk	16— ,,	2— 3 ,,

* Kindly supplied by Mr C. R. Nodder, Jute Technological Research Laboratories, Tollygunge.

with Hiparol the time required for retting varied from 1-3 days, depending on the type of plant tissue used. Jute and crotolaria were retted in 3-7 days by bacteria and in 1-4 days by Hiparol. Crotolaria is easy to be retted by Hiparol, whereas with bacteria the fibre bundles are disorganized easily just after the completion of retting. In the enzymic process by Hiparol, the plant tissues are broken down by the enzyme complex (lamellase, pectinase ; –Baruah 1942) by the breakdown of the middle lamella and the decomposition of pectins resulting in the loss of coherence of plant tissues. In the bacterial process, plant tissues are initially attacked by the enzymes already present in the bacterial extract and later broken down by enzymes capable of causing breakdown of the middle-lamella and of pectins secreted during the growth of bacteria. In the first instance, it is the enzymes alone that are responsible for the breakdown of plant-tissues, whereas in the latter the whole phase of retting involves primary softening by bacterial enzymes already present, lamellase potency of which is, however, low, and in which rapid growth of bacteria and production of active enzymes are capable of breaking down tissues (details to be published later).

Utilization of Jute Root Cuttings in Industry

"Cleaning" and "softening" of Jute Root-Cuttings.—The basal portions of jute fibres, known as root-cuttings, are usually not suitable for spinning due to large quantities of adhering ligneous matter and have always presented a difficult problem to the jute mills, as it involves a considerable loss to the jute industry. Ease of retting is generally influenced by the degree of hydrolysis of the pectic cell-walls and mechanical resistance of the skin and the time required for retting varies in different regions of the plant (Baruah and Baruah, 1944). In the production of fabrics that comprise jute-bags, packs, pockets and sacks and of sacking weft mixes, the method used at present includes extensive carding and softening, using 40 to 60% emulsion, stacking the cuttings in piles for a period of 7 to 10 days and subsequent teazing to present moderately "clean" fibre in Tow form at the Breaker. This method of processing is far from satisfactory due to presence of large quantities of adhering bark, high cost of batching (Rs. 15-16 per ton of cuttings), unevenness of moistrue content of the fibres and decrease in tensile strength of the resultant yarn and cloth (Watson and Baruah, 1945). If jute cuttings or jute of poor quality can be freed of adhering bark by a process that will ensure uniform quality of "clean" fibres and satisfactory spinning, it will be possible to use root-cuttings or jute of poor quality not only for sacking but also for spinning and weaving various kinds of textiles. The process using Hiparol and bacterial enzymes was, therefore carried out on root-cuttings, retting being done in tanks containing certain raw materials (S. B. L. G. H. system of retting), favourable for the growth of the bacteria concerned and the activity of enzymes (rate of activity to be determined by the extent of changes in viscosity of pectin and amount of reducing sugar formed after 3 hours). The reaction mixture in the tanks was maintained at 85-90°F at *p*H 6·0 to 7·0. A modification in the process had been made by introducing a system of aeration from an air-compressor at definite intervals. The time required for the removal of bark varies from one to three days after which the fibres are removed from the tanks, washed and dried in the sun. Samples of cloth, prepared from jute-cuttings and treated by this process, show greater weights per square yard and higher tensible strength than the standard mill quality samples. The weft yarns are more compactly spun as a result of better softening of the treated cuttings, indicating no enhancement of fibre slippage due to processing and no weakening effect of the treatment on the fibre (Watson and Baruah, 1945).

Table IV gives the results of tests on number of threads per inch—weight per square yard and tensile strengths of strips of two inch widths of samples of cloth prepared by this process ('A' & 'B') and of standard mill quality ('X'). The composition of samples processed by Watson and Baruah (1945) is as follows :—

(*i*) Standard mill quality—'X'—50% root-cuttings, 25% H.J., 10% ropes, 2% caddis, 1% gunny cuttings, 12% wastage.

(*ii*) Enzyme treated root-cuttings—'A' –72% root cuttings, 8% H.J., 5% ropes, 5% wastage, 5% caddis, 5% gunny cuttings.

(*iii*) Enzyme treated root-cuttings—'B'—72% root cuttings, 8% H.J., 5% ropes, 5% wastage, 5% caddis, 5% gunny cuttings. Details of method of processing are described by Watson and Baruah (1945).

Test results.—I. J. M. A. conditioned tests. 6 × 8 × 26½. 'B' Twill.

Samples of cloth had also been prepared by utilizing 100% jute root cuttings treated by this process. It may be noted that samples 'A' and 'B' containing 72% jute cuttings show better results than sample 'X' containing 50% root cuttings. (Watson and Baruah, 1945).

TABLE IV

NUMBER OF THREADS PER INCH, WT. PER SQ. YD. AND TENSILE STRENGTH OF STRIPS OF 2" WIDTHS

Samples	No. of threads per inch		Wt. in oz. per sq. yd.	Tensile strength of 2" wide strips				Tensile strength of weft in lbs. divided wt. in oz. per sq. yd.	
				7" between grips		3" between grips			
	Warp	Weft		Warp	Weft	Warp	Weft	7" between grips	3" between grips
				lbs.	lbs.	lbs.	lbs.		
X	12	8	17·76	248	164	269	182	9·23	10·24
A	12	8	18·24	252	171	282	220	9·38	12·06
B	12	8	19·37	250	229	276	242	11·82	12·49

(Test kindly carried out by Dr W. G. Macmillan, Indian Jute Mills Association Research Institute, Calcutta).

The industrial application of this method of retting would envisage a battery of tanks, the number of tanks to be decided upon by the amount of cuttings to be processed in sack-weft and sack-warp. Raw materials to be added to the tanks are cheap and the total cost per ton of cuttings processed, including raw materials, washing, drying, labour, maintenance and power, will be approximately Rs. 9/-. By using certain mechanical devices, it will be possible to reduce this cost further (details to be published later). Root-cuttings were kindly supplied by Bengal Jute Mill Co. Ltd., Howrah.

The extent of breakdown of plant-tissues during hydrolysis by Hiparol and by bacteria has been followed by determining the amount of cell-wall material (prepared from the plant tissues by drying and powdering) decomposed and the amount of reducing sugar formed after 24 hours (Table V). The method was the same as used before (Baruah, 1942).

Nature of End-products formed during hydrolysis by Hiparol and by Bacteria.—Hiparol contains, besides pectin-splitting enzymes, carbohydrates which break down starch and other carbohydrates (bajra, maize, molasses, rice, sugar-cane, sweet-potato and potato) by a sequence of changes and produce chiefly acetone, butyl alcohol and ethyl alcohol. The diastase value of Hiparol compared to that of *A. oryzae* indicates the possible use of Hiparol as a source of diastase and also in the desizing of starch and gummy substances from textiles (relative viscosity of a 2·5% starch solution is reduced to 24·9% of its initial value after 30 minutes when acted upon by Hiparol). The end products of bacteria are chiefly acetic and butyric acid. Galacturonic acid which is produced by the

TABLE V

AMOUNT OF CELL-WALL MATERIAL UNDECOMPOSED AND OF REDUCING SUGAR FORMED DURING HYDROLYSIS AFTER 24 HOURS

Type of plant-tissues	Initial weight		Amount undecomposed		Amount of reducing sugar	
	Hiparol	Bacterial Enzymes	Hiparol	Bacterial Enzymes	Hiparol	Bacterial Enzymes
Coconut	1 gm.	1 gm.	0·82 gm.	0·662 gm.	0·16 gm.	0·08 gm.
Jute	1 ,,	1 ,,	0·50 ,,	0·703 ,,	0·32 ,,	0·02 ,,
Gerardinia	1 ,,	1 ,,	0·70 ,,	0·709 ,,	0·18 ,,	0·019 ,,
Bauhinia	1 ,,	1 ,,	0·66 ,,	0·709 ,,	0·20 ,,	0·018 ,,

It will be seen from Table V that the rate of decomposition of coconut husk is higher with bacteria than with Hiparol, whereas with gerardinia, jute and bauhinia, Hiparol is more effective than bacteria. The amount of reducing sugar formed is less with bacteria than with Hiparol because sugar formed in proportion to the amount of pectin broken down is probably utilized by the bacteria.

breakdown of pectin by both Hiparol and bacterial enzymes (Pectin—Polygalacturonase—Baruah, 1942) can possibly be separated and synthesized to vitamin C (details to be published later).

Conclusions

The sequence of changes in retting of fibrous plants by bacteria and bacterial enzymes is similar to that caused by Hiparol, a mixture of enzymes secreted by *Thielaviopsis paradoxa*, in so far as breakdown of pectin and the middle-lamella is effected by the enzymes. In the enzymic process by Hiparol, fibrous plants are retted by the enzymes already available for the decomposition and hence the decomposition is more rapid, whereas, in the bacterial process, the plants are primarily softened by enzymes already present in the bacterial culture together with spores and are further attacked by bacteria which grow from the spores and produce enzymes capable of breaking down tissues. Hiparol appears to be more active than bacteria since the time required for retting is less than that required by bacteria ; with bacteria, however, it is possible to enrich the retting water by the specific bacteria concerned in retting. The idea is to ensure the presence of the maximum number of cells of the particular organism concerned in retting and thus ease the establishment of the bacterial colony on the plants and cause their decomposition. It should be possible in the production of sacking or packing goods to utilize the basal portions of jute fibres (root cuttings) or jute of poor quality in the mill by "cleaning" up and "softening" the cuttings by Hiparol and bacterial enzymes, eliminating thereby the extensive carding, softening and peeling operations at present used and ensure regular processing and increase in cloth strength. If the bark or speckiness of jute cuttings or of jute of poor quality is removed it is possible that jute-cuttings and poor quality jute will fetch a higher price than what they are now because the future of the jute-industry depends on the successful, application of new finishes to jute fabrics and this, in turn, is dependent on the production of a "clean" fibre free from bark.

Retting of flax by Hiparol may be of advantage, since, in retting by bacteria, fibre bundles are easily disorganized due to over-retting and are unfit for spinning. Retting of coconut husk can be more readily effected by using Hiparol or bacteria and bacterial enzymes than by the ordinary method of stacking in water, and the quality of fibre can thus be improved. Retting by Hiparol or by bacteria and bacterial enzymes provides, therefore, a method of separating the fibres held together by gums and pectins without injuring the fibres and may introduce to the textile industry the possibilities of processing various fibres such as, ramie, hemp, coconut, gerardinia on modified jute or cotton machinery. It has been also demonstrated that bacteria can with ease be cultured by the method used here and enzymes extracted for studying their rates of activity. The application of this method should allow a vast amount of information to be gained about biochemical reactions caused by bacteria as well as about bacterial fermentations.

Summary

1. Bacteria responsible for retting are isolated and enzymes extracted ; rates of activity of Hiparol, enzymes extracted from *T. Paradoxa* and bacterial enzymes are studied.

2. Hiparol and the enzyme preparations from bacteria cause maceration of the tissues by attacking the middle-lamella and breaking down pectin by a sequence of changes, both physical and chemical, to reducing sugar, galacturonic acid and methyl alcohol.

3. The time required for retting of jute, coconut, ramie, by Hiparol and by bacterial enzymes varies from 1—7 days, depending on the type of plant tissues used. Hiparol is more active as a retting agent than the enzyme preparation of bacteria.

4. Samples of sacking cloth had been prepared from jute root-cuttings by "softening" and "cleaning" by Hiparol and bacterial enzymes and processing in the mill ; the possibilities of utilization of Hiparol and bacterial enzymes in industry are indicated.

5. The process of recovering the end-products formed, chiefly, galacturonic acid, acetic acid, butyric acid, acetone, butyl alcohol, ethyl alcohol during hydrolysis by Hiparol, and bacterial enzymes provides a wide field for investigations on fermentations by enzymes.*

References:

1. Barnah, H. K. Experimental studies on the parasitism of Citrus Fruits by *Penicillium digitatum* Sach. Cambridge Univ., Ph.D. Thesis, 1942.
2. Baruah, P. and Baruah, H.K.—Retting by Hiparol and its commercial application. Science and Culture, *10*, 201-205, 1944-45.
3. Rossii, G.—*Bull. Agric. Intell.*, *7*, 1067, 1916.
4. Thaysen, A. C. and Bunker, H. J.—Studies of the Bacterial decay of Textile fibres. *Bioch. Journ.*, *18*, 140, 1924.
5. Watson, C. M. and Baruah, H. K.—On certain Aspects of Processing Jute in Industry—In Press (1945).

* We are grateful to Dr D. M. Bose for his kind interest and for giving us all facilities for work and to Dr W. G. Macmillan for his helpful suggestions.

MEDICINE AND PUBLIC HEALTH

HEALTH IN INDIA

DURING his recent address before the Bengal Medical Conference at Asansol, Dr K. K. Sen Gupta painted a gloomy all-India picture and emphasized the urgency of health problems. He said, 'Over 6 million people die from communicable and preventible diseases every year, and the expectation of life which is about 63 years in Australia is only 27 years in India'. He recognised that the absence of a national health policy was the root cause of the evil. Rural areas in India has on an average one doctor for every 70 villages or one doctor for some 40,000 people.

It has been estimated by the National Planning Committee that there must be at least 400,000 medical men to provide a full medical unit for every 1,000 people. Dr Sen Gupta suggested that to get more doctors India could follow the example of Soviet Russia. In 1914, Russia had one doctor for 7,200 people. To remedy the evil Government multiplied their medical institutions which worked double shift and by 1940 their number was raised to one doctor for every 1,500 people. To encourage doctors to settle in villages, the Health Ministry guaranteed by legislation the status and comfort of the country doctor.

Dr Sen Gupta demanded that the Government should assume complete control over medical matters, *viz.*, those concerning medical education and services, registration, manufacture of drugs and medical accessories. An act should also be promulgated for the summary trial and punishment of all persons guilty of food and drug adulteration.

We fully endorse the views expressed by Dr Sen Gupta and urge the Government to shake off its *laissez faire* policy with regard to health problems in India. A national health policy is urgently needed to fight the evils, and without it there could be no improvement of the public health of the country.

BACITRACIN—A NEW ANTIBIOTIC SUBSTANCE

THE discovery of a new antibiotic substance recovered from a strain of the *B. Subtilis* group of organism has been announced by a group of three workers, B. A. Johnson, H. Anker and F. L. Meleney, in *Science*, October 12, 1945. Certain rod shaped bacteria isolated from wound infections were found to inhibit the growth of other bacteria grown in the same laboratory dishes. One strain isolated from tissue debrided from a compound fracture of the tibia was particularly active. Pure broth cultures of the bacillus, from which living cells were filtered, possessed strong antibiotic activity, and investigations were undertaken towards concentration and isolation of the active principle which has been given the name "Bacitracin".

The new antibiotic substance is neutral, water soluble, non-toxic and relatively heat-stable. *In vitro*, it attacks chiefly Gram-positive organisms such as spreptococci and staphylococci, but the gonococcus and the meningococcus are also susceptible to its action. *In vivo*, it is active against experimentally produced haemolytic streptococcal infections in mice and gas gangrene infections in guinea pigs. Trial on human volunteers has produced encouraging results against local haemolytic streptococcal and staphylococcal infections.

KAMALA AS A COLOURING AGENT FOR HYDROGENATED VEGETABLE OIL: ITS TOXICITY ON WHITE RATS

J. C. GUPTA AND M. L. CHATTERJEE,

DEPARTMENT OF PHARMACOLOGY, SCHOOL OF TROPICAL MEDICINE, CALCUTTA

"KAMALA" has been suggested for use as a colouring matter to render vegetable oils easily distinguishable from *ghee*. The present work was taken up at the request of the Government of India to find out the toxicity of the drug when used as colouring agent for edible oils or fats.

Rothera tinctoria ROXB, or *Mallotus philippinensis* is a small evergreen tree belonging to Euphorbiaceae or Spurge family, grown throughout tropical India. This tree bears capsules which are covered with numerous minute glands and hairs. "Kamala" consists of these glands and hairs covering the capsules. It occurs as an odourless, nearly tasteless granular brick red powder, insoluble in cold water, sparingly soluble in boiling water, fairly soluble in alkaline solutions, and alcohol ; it is, however, readily soluble in ether. Warm oil dissolves in it a large proportion of the dye, forming a deep red solution turning, when set, to orange yellow, golden yellow or yellow, depending on the concentration of the dye used in the solution. This changing in colour in oil, when setting, renders it very difficult to fix the standard and match the colour by means of a Lovibond Tintometer.

The value of "kamala" powder as an anthelmentic against Taenia was recognized even as early as in the last century (Waring 1874). Its remedial effect against threadworms, roundworms and hookworms was once claimed, but later disproved by the same worker (Tarapore 1912). This drug was tried and proved to be a failure against hookworm and roundworm infection (Cains and Mhaskar, 1921).

Numerous chemists have investigated "kamala", and at least six distinct substances have been isolated. The most important of these is rottlerin, a derivative of phloroglucinol intimately related, from a chemical and pharmacological point of view, to filicin of 'male fern', and kosin of kuosso.

Regarding the toxicity of the drug, Semper (1910) carried out experiments on frogs, tadpoles and worms and found a striking paralyzing effect on the motor nerves and muscles of frogs. On the other hand Semper came to the conclusion that "kamala" and its products are not absorbed when given orally to dogs. It is commonly stated, however, that in full doses (*i.e.*, in 2 to 2½ drachm doses) the drug is actively or even violently purgative, causing in many cases considerable nausea and vomiting.

After preliminary experiments on cats, rats and guineapigs, investigations were done on white rats of known weights (*viz.*, 100 to 150 gm), having measured quantity of diet mixed with *dalda* (hydrogenated vegetable oil) coloured with "kamala" dye or powder, along with other rats similarly without the dye. The daily dose of the powder or the dye from it, used in the oil, was kept constant throughout the course of experiments and this was higher than or approximately equal to the maximum single dose used as anthelmentic on human adult. The daily quantity of the oil thus coloured was according to the basis of weight in proportion to human adults (calculated as 50-60 kgm). The temperature of the oil was raised daily to ordinary cooking temperature (*i.e.*, 160°-170°C) before its administration with food. The dye or the powder was administered daily for varying periods from 6 weeks and to 6 months.

Three different varieties of coloured *dalda*, used in the experiments, were prepared as follows:—

1. By cooking the powder in 5 per cent concentration in *dalda* for 10 minutes at a temperature of average 160° to 170°C, in the presence of moisture, as is obtained in ordinary cooking. This cooked powder was allowed to remain in *dalda* (unstrained).

2. By following all conditions as above, the only difference being that the cooked powder was strained out, thus allowing only the dye agent to remain in solution in *dalda* (strained).

3. By heating *dalda* alone to the above temperature and then keeping "kamala" powder in 5 per cent concentration in contact with hot *dalda* for 15 minutes, subsequently straining off the kamala powder, allowing only portion of the dye soluble in hot dalda to remain in solution. The oil was prevented from setting by keeping it in contact with warm water, during the period of extraction of the dye.

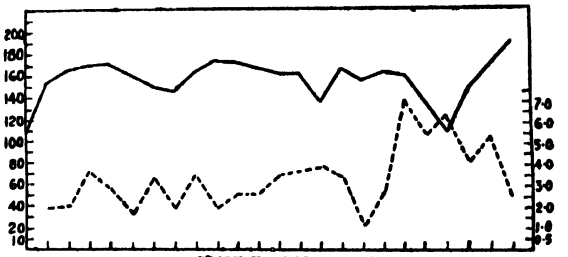
It may be noted, however, that during the course of experiments spread over a period of six months, the above stocks of *dalda* were prepared, once and for all, before the commencement of experiments. Each day the required amount was heated to about cooking temperature for a short time prior to mixing them in definite quantity with the weighed amount of diet of animals. The quantity of *dalda* was the same in all, *viz.*, 4 c.c. per kgm. body weight. The

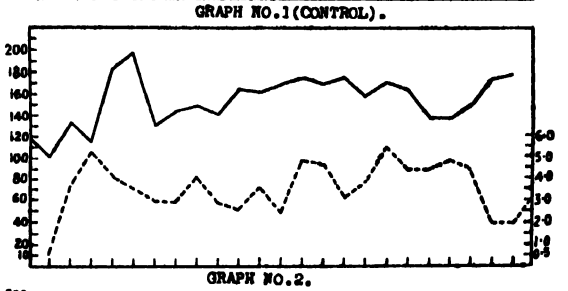
six series of rats used in the experiment, were distributed as follows:—

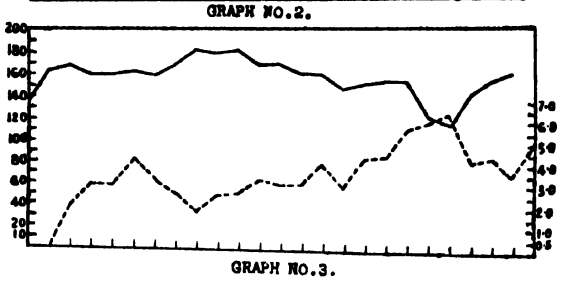
The first series was used as control by administering only *dalda* with food of animals in such quantity which may be considered maximum for human consumption ordinarily (*i.e.*, 4 c.c. per kgm. body weight, which is equivalent to a little over 6 ounces for an average adult weighing 50 kgm.). (Results in Graph No. 1).

The second, third and fourth series were given varying proportions of the dye in *dalda* containing the cooked "kamala" powder from the stock noted under (1) above. The concentration used per kgm. weight of animals were 0·2 gm (*i.e.*, 4 c.c. of 5% solution), 0·05 gms/kgm. (*i.e.*, 1 c.c. of 5% solution), 0·025 gms/kgm. (*i.e.*, 0·5 c.c. of 5% solution)—daily respectively. It may be noted that the dose of 0·2 gms/kgm. is equivalent to 10 gms. or approximately 2½ drachm for an adult of 50 kgm. (Results in Graphs 2, 3, 4).

The fifth series was given from the stock dyed *dalda* noted under (2) above, in a concentration of the dye equivalent to 0·2 gms/kgm (*i.e.*, 4 c.c. of 5% solution per kgm.) of the kamala powder. (Results in Graph No. 5).



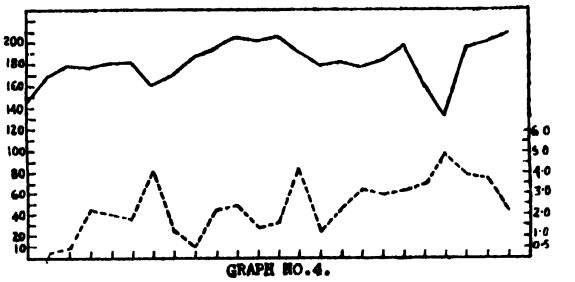


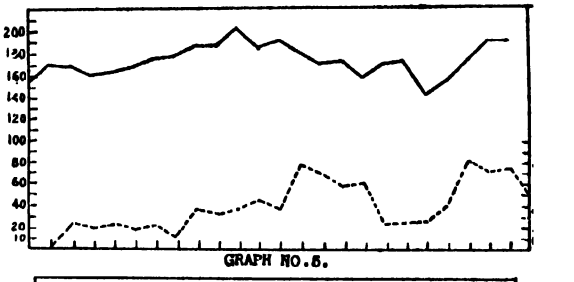


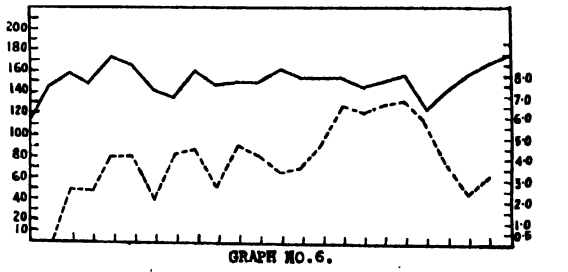
Graph No. 1. (*Control*) *Dalda* only 4 c.c./kgm. body weight.

„ „ *2.* —Concentration of powder (5%) unstrained and cooked. Dose—*0·2 mgm/gm.* which is equivalent to 10 gms. for an adult of 50 kgm.

„ „ *3.* —Concentration of powder (5%) unstrained and cooked. Dose—*0·05 mgm/gm.* which is equivalent to ¼ of the dose used in *Graph No. 2.*







Graph No. 4. (*Control*)—Concentration of powder (5%) unstrained and cooked. Dose—*0·025 mgm/gm.* which is equivalent to ¼ of the dose used in *Graph No. 2.*

„ „ *5.* Concentration of powder (5%) cooked and strained. Dose—*0·2 mgm/gm.* which is equivalent to 10 gms. for adult of 50 kgm.

„ „ *6.* Concentration of dye as obtained from (5%) powder in hot *dalda* for 15 minutes (Note that the powder was not cooked in oil) and then strained. Dose—same as in *Graph No. 2.*

Note: (*a*) The quantity of oil in control as well as in the experiments was the same in all cases (*i.e.*, 4 c.c./kgm. body weight).

(*b*) Figures on the ordinate of the graphs indicate weight in grams and those on the abscissa weeks of experiments.

(*c*) Straight line indicate weight of animals and dotted line that of rejection of food in grams.

The sixth series received from the stock noted under (3) above (*i.e.*, daily dose per kgm. was 4 c.c. of *dalda* dyed with 5% "kamala" powder). (Results in Graph No. 6).

Apart from observation in changes in weight, and the rate of intake of food by the rats, histological studies on sections of liver, kidney and suprarenals were made at varying periods for evidence of toxic manifestations, if any, to the presence of colouring matter or the powder itself. Materials for histological studies were collected by stunning the animals at different periods in the course of investigation:—(*a*) after the completion of 6 weeks, and (*b*) after the completion of 12 weeks, and (*c*) others just after 24 week ; with a view to observing changes, if any, produced after long continued feeding of the dye.

Weekly records of weight and of intake of food during the period were maintained for the purpose of determining the toxic effect of the dye as reflected on body weight of the group of rats used in the experiment. It was noted that the animals irrespective of the form in which the dye was used, rejected from time to time, the effect of which was reflected in the weight of the animal on the following week.

It will be seen, however, from the curves that the variation in the amount of rejection of diet by different groups of rats, including the control group, is nearly of the same order, having no particular relation to the admixture of the "kamala" powder or its dye. The curves further tend to indicate a negative correlation between the weight of the animal and the rejection of diet in all the groups. This fluctuation of weight in the different groups of animals is not of great magnitude and is practically of the same order. The explanation regarding this fluctuation in weight, as seems dependent on the rejection of food, is due, perhaps, to the satiety caused by the oil administered in food which is not a normal diet for this animal, since the group which had received no dye and served as control also showed similar disinclination to food from time to time and a consequent loss of weight on the week following.

The histological evidence in liver, kidney and suprarenal glands of white rats fed on *dalda* with "kamala" after 6 weeks, 12 weeks, and 24 weeks showed no structural changes even with a high dose of 0·2 mgm. per gram weight of the rats.

Summary and Conclusion

1. The present paper is a study into the toxicity by oral administration in white rats of a vegetable dye ("kamala" powder or, *Mallotus phillippinensis*) in a vegetable oil (*dalda*) extending over a period of 6 months.

2. An attempt has been made to find the correlation between the average rejection of diet, average weekly deflection in weight and the toxicity of the "kamala" dye.

3. The changes in the weight of rats under the dye or kamala powder and of those under the control experiment appear to be of the same order in all the different groups of experiment and are, therefore, more due to the rejection of diet, which may arise either from the satiety caused by the oil which is not a natural food for rats or due to some factor other than the toxicity of the dye.

4. Absence of histological changes in the structures of liver, kidney and suprarenals of rats examined at different intervals (*viz.*,—one and half months, 3 months and six months) indicate the absence of toxicity of the drug even when given in fairly high concentration.

Reference:

1. Cains, J. F. and Bhaskar, K. S.—*Ind. Jour. Med. Res.*, 9, 202, 1921.
2. Semper, A. *Arch. Expl. Path. and Pharm.*, 63, 10, 1010.
3. Waring, E. J. Bazaar Medicines. 1874.
4. Tarapore, P. K.—A note on Ankylostoma Infection and Ankylostomiasis in the Mandalay Central Jail. 1912.

BOOK REVIEWS

There's Work for All—by Michael Young and Theodor Prager. Published by Nicholson and Watson, London. Price 5*s*. net.

In this booklet published by Nicholson and Watson under the 'New Democracy Series', the problem of full employment and its possibilities are fully explored. Full Employment and Social Security are indeed the twin objectives of all contemporary capitalistic planning and of these two the former gets precedence. As Beveridge has put it, the destruction of the giant of Idleness will pave the way for the tackling of the other four giants *viz.*, Want, Squalor, Ignorance and Disease. In the immediate post-war period it is this contingency that is staring the millions of workers in Britain and other countries in the face that of "getting the sack". In fact all the bigger promises of Britain will be empty and void if she can not prove herself equal to this task of providing work for all who are willing and able to work. The writers have, as non-technically and thoroughly as is possible within the short space, explained the latest and the most accurate theory of mass unemployment with which Lord Keynes has familiarized us in his "General Theory of Employment, Interest and Money". The concepts of under-spending and under-consumptions are ably discussed and the relation between consumption-demand and investment-demand is lucidly explained. The course of the trade-cycle is illustrated with charts and photographs in such a way that it directly brings home to the reader the exact state of affairs. The causes of general unemployment are discussed and the so-called 'remedies' are pronounced to be inadequate. The White Paper on Employment Policy by His Majesty's Government is found to be little more than a confusion of thought. Even if the scheme outlined does work, it will fall miserably short of the actual requirements. The changes in social Insurance contributions will be hopelessly inadequate "to offset any substantial fall in consumer spending". The real remedies ultimately reduce to two *viz.*, enlarging the scope of public investment according to "standards of social priority" and redistribution of income from the rich to the poor with a view to increasing the "propensity to consume". Allied necessities of Government control over the capital market as well as over bank credits, some form of price-control and the operation of certain basic and key industries by the Government are also considered.

Even though general unemployment can be thus conquered, special types of unemployment would still remain, each for its own appropriate policy. Thus the writers face the problem of "casual unemployment" and discuss the war-time elimination of this form—the "decasualization" which has been made a reality. Seasonal unemployment has only one remedy, the provision of alternative occupations for seasonal workers so that there is always something for them to do in the off-season. But the most formidable enemy is that of structural unemployment and the remedy for this is a well-planned location of industry. "The rule should be that industry should move to the labour, not labour to industry."

The international aspects of full employment are considered and it is found that the popular misapprehensions that U. S. A.'s economic and foreign trade policy would run counter to Britain's aim at maintaining full employment are groundless. The writers close with a discussion of the plans to be undertaken in the immediate post-war period—those of health, housing, sanitation, education, transport and so on. They conclude that if these plans are truly conceived and properly executed, there will be not shortage of work but shortage of labour. The spectre of unemployment will be a thing of the past. To this effect, a Four-year Plan, rather a series of Four-year Plans, is warmly recommended. An inquisitive reader would ask whether the special sanctity which the writers seem to attach to *Four-year Plans* is because of the Russian association with *Five-year Plans*.

The brightest feature of the book is its wealth of pictorial charts designed by the Isotype Institute and photographs. In its marvellous collection of 14 pictorial charts and 84 photographs, its superfine get-up and its masterly discussion of the subject-matter, it represents in every respect an ideal which our Indian publications ought to aspire after.

T. K. B.

Flowers in Britain (wild, ornamental and economic)—By L. J. F. Brimble. Pp. x+394 with 17 plates and 167 text figures. Macmillan & Co. Ltd., London. Second impression, 1945. Price 12*s*. 6*d*.

This is a book primarily meant for the layman. No previous knowledge of botany is assumed and thousands of non-botanists wanting to know about Britain's flowering plants may read this with profit. It is not unusual to find academic botanists who are often unfamiliar with garden flowers, and their knowledge regarding them is often much less than

the ordinary gardener. The book is intended for them as well.

Apart from the garden plants, the relationship of such plants with the wild species and the origin of most of the British garden flowers, fruits and vegetables are given. The subject of garden flowers become complicated with its large varieties and hence only those well-known are mentioned. The book in addition contain chapters on the structure of plants, their classification, habit and habitat, and the part played by plants in history and folk-lore.

An admirable feature of the volume is the way in which the author has enriched his descriptive accounts not only with copious pictorial illustrations —which is usual—but with poetical illustrations as well—which is more or less unusual and shows perhaps that the true botanist is also something of a poet ; he must have an exquisite feeling for form and colour and touch—such as should turn a mere man of science into a hedonist of sensations. After all by nothing is English poetry so distinguished as by its 'floweriness',—and since Shakespeare's "Daffodils" 'took the winds of March with beauty', a rich procession of poets have made English flowers a thing to dream of even to many who have never seen them,—and Botany "something more than Latin names".

But for a few mistakes that could be corrected in the next edition the book is an admirable production in botanical literature.

C. clitorious in p. 380 should be corrected as *C. olitorius, Hyocyamus* in p. 382 to be corrected as *Hyoscyamus*. In the index *Armeria maritima* is mentioned in p. 245 and not 244, similarly Queen Victoria in p. 239 and not in p. 177. The morphology of the banana needs revision in the light of recent investigations.

A bibliography of references at the end of the book would be useful for the inquisitive mind.

A. K. G.

Beautiful Flowers of Kashmir —By Ethelbert Blatter. Vol. II. Pp. xvi + 204 with plates 28, figures 168. Staples and Staples Ltd., London.

A reprint of the Volume I of this book was reviewed earlier (SCIENCE AND CULTURE, July, 1945) and we are glad that the Vol. II has appeared soon after to complete the set. The second volume appeared for the first time in 1929 and it is encouraging to note that books of this nature has now a wider demand.

This volume includes the families *Compositae* to *polygonaceæ, Gnetaceæ* and *Hydrocharitaceæ* to *Halorrhagidaceæ*. It is written on the same plan as Vol. I excepting that the derivation and meaning of the botanical names have been added. If facts concerning the economic uses and folk-lore of the various plants were added, the book would have been comparable to Brimble's book reviewed above. A key for the identification of species and the glossary will be very useful to those for whom the book is intended.

The erroneous position of *Liliaceae* in p. 168 should have been corrected in this reprint.

The review would be incomplete without a word of praise for the illustrators, Mrs G. A. Wathen and Haldar Joo Walli.

A. K. G.

Economic Policy and Programme for Post-war India —By Nalini Ranjan Sarkar. Published by the Patna University.

In the brochure published by the Patna University as Banaili Readership Lectures, Mr Nalini Ranjan Sarkar, stresses the urgent need for a planned development of Indian Economy in the immediate post-war period and shows the lines along which it should progress. The appalling poverty and the abnormally low standard of living are brought into clear relief and the observation of the *Economist* is quoted with approval: "The Indian worker spends in a year what the British worker spends on cigarettes". The real problem is how to raise the per capita income by augmenting the quantum of wealth and from this point of view, the exclusive attention on agriculture, which has become a fetish with the Government of India, of late, is severely criticized as a fundamentally wrong emphasis. The fundamental question today seems to be not so much the improvement of agricultural methods in order to sustain the fast increasing pressure of population on land, for here the bottleneck will be reached very soon, but to release this pressure by providing alternative avenues of employment in industrial and other occupations.

With the need for industrial development at a fairly rapid pace thus established, the need for a well-planned approach becomes paramount. Much harm has been wrought in the past by the essentially unco-ordinated and planless nature of our economic development in general and industrial development in particular. As a direct consequence, the startling paradox of "poverty in the midst of plenty" stares us in the face.

So we have to plan, and in planning our target should be "Big Five" *viz.*, the adequate provision of the five items of food, shelter, clothing, health services and education. In monetary terms, the standard of per capita income, Mr Sarkar thinks, is difficult to calculate. The Rs. 74/- suggested by

Bombay Plan is taken by him to be the "barest minimum" and in fact, a similar figure he seems to have in mind while describing a subsistence minimum up to which there should be an absolute equality of income level.

He makes a careful study of the resources at our command and estimates our agricultural, forest, mineral and livestock resources, capital and savings and man-power. The overall position regarding natural resources is summed up thus ; "In absolute terms they are not inconsiderable. But when related to the 400 millions of our population, the resources per head considerably thinner." Naturally, they do, but does it give any ground for pessimism in planning? Furthermore, stress must be laid on our unexplored resources which the writer has mentioned in passing. Finally, however, he comes to the conclusion that "Vast as our requirements are, the two (resources and requirements) together leave no disheartening chasm between them."

The cry of agriculture *vs.* industry is duly considered and it found out that they are "complementary to an unexpected degree". Regarding the planning of agricultural production, the scope of co-operative farming, manuring and use of fertilizers, reform of land revenue system, etc., are examined and an instructive discussion on Tennessee Valley Authority and its lessons for us, is added. In industrial planning, the question of priorities is touched upon. In common with many other writers the present author warns us of the mistakes of Russian planning in putting too much emphasis in the initial stages on durable capital goods which take a long time to come into being. India should take a useful cue from that if the hardship on consumers is to be minimized. Another peculiar characteristic which India shares with Japan is her relative superabundance of labour and scarcity of capital and the consequent utility and need for cottage industries is taken proper notice of. Allied problems of protection, location of industry, transport etc., are also considered.

In discussing the distributional aspects of the plan and the role of the State in it, Mr Sarkar is treading on controversial grounds and is fully conscious of it. He steers clear of political partisanship and ideological conflicts and in the field of State Control, prefers the Aristotelian "golden mean". "State ownership" he frankly declares, "has no magic for me". Louis Fischer's system of checks and balances outlined in his "Men and Politics" is warmly approved. Private initiative and State Control should not be at cross-purposes, but should "pull the national wagon side by side". In theory, it is quite attractive, but in the field of actual execution, difficulties seem to be legion. Private initiative, if it is to be properly controlled and prevented from running at cross-currents with State initiative, may, at times, dwindle to nothing and we must be prepared for that contingency. The real trouble is that so long as the State machine is run by the wielders of economic power—a syndicate of capitalists—the ultimate object of planning "the greatest good of the greatest number" as Bentham would have it, can never be achieved and so you have to come to some form of Socialism.

Regarding distribution, he thinks of absolute equality as impracticable. He believes in Laski's definition of equality as "essentially a problem of proportions". But it is difficult, and the writer should have admitted that, to predict what that proportion is going to be. In this field, it is wisest to refrain from attempting to give an exact picture of the shape of things to come.

Barring a few conterversial topics which he has discussed, the writer has generally confined himself to well-accepted observations and recommendations and we hope the reader will find a thorough and overall survey of the problem of planning and its implications. He will be disappointed if he expects to find something strikingly original in it, but here is a very useful compendium and commentary on the various plans that have been put forward from time to time. Perhaps one would have wished the problems raised herein to be discussed in greater details, but one would realize that no better justice could have been done to them within the space at the writer's disposal.

T. K. B.

A Class Book of Geology of India (for junior students)—By N. C. Mittal, B.Sc., F.G.S., M.R.A.S., M.M.G.I. To be had of Messrs. Malhotra Bros., Jammu ; Pp. 108, with 2 maps ; Price Rs. 2/8/-.

A text book on Indian Geology for students preparing for Intermediate Science Examination in Geology in the Indian Universities is in great demand. The present book claims to be one for such purpose. Unfortunately it has not been written with as much care and attention as such a book demands. As a result it has come out extremely scrappy and sketchy. Even a cursory reader cannot but be struck by its desultoriness.

The book would have been much more useful had the chapter on "Physical Features" been less fragmentary and had contained a little more matter, had the stratigraphical details been sacrificed to a better and more elaborate treatment of the geological deductions and reconstructions, and had more information of practical and general interest been added to the chapter on "Economic Geology". The

section on Archaean rocks is particularly out of date and even incorrect at several spots; the Vindhyan formation, the Siwalik mammals should have received greater attention, and the names of ores of many metals, so glaringly missing ought to have found place.

The two maps attached ill serve the author's purpose, the map showing mineral distribution particularly.

There is a lot of printing mistakes.

S. K. R.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

RETTING BY HIPAROL AND ITS COMMERCIAL APPLICATION

The following is the criticism of the article – Retting by Hiparol and its Commercial Possibilities by Mrs. P. Baruah and Dr H. K. Baruah, published in SCIENCE AND CULTURE, Vol. X, page 201-205, 1944.

The practical possibilities of the enzyme called Hiparol, as claimed by the authors of the article, appears from the work done to be rather hastily concluded from small scale and purely Laboratory Experiments without any proper control. There are also certain mis-statements and contradictions in the article which exaggerate the claims put forward. Some of these may be mentioned as follows:—

1. In jute 15 to 20 days are usually taken for retting under normal condition and not 6 to 10 weeks or more as stated.

2. In table 4, it is shown that immature jute takes longer time to ret than mature jute *i.e.*, 30-40 hours as against 18-34 hours. In common experience it is just the opposite.

3. In the middle of page 204, first column, the authors again state that the apical portion (*i.e.*, immature) took 12-18 hours as against 24-40 hours of middle and basal portion (*i.e.*, mature), which itself contradicts the result shown in table 4.

4. The work has been conducted with small portions of stems as 2 cm., 7″ bits, or single plant. The value of the data would have been greater if larger quantities of plant material have been used.

5. From the paper it is evident that with increase in volume of the material used the time for retting with Hiparol also increases.

With 2 cm. bits retting period is shown 8-10 hours.

With 7″ bits retting period is shown 18-24 hours.

With single plant retting period is shown 96 hours (or 4 days).

In practice single plants are never retted. They are steeped in bulk consisting of bundles of 100 plants or so. If from 2 cm. bits taking 8-10 hours, the time of retting a single plant increases to 4 days and if the duration of retting period is proportionate with the volume of the material steeped, it can be imagined how long bulk steeping in Hiparol will take, compared to natural steeping method, which takes only 15-20 days.

6. At no stage the authors appear to have used retting in ordinary water as control. Even if the effectiveness of the new enzyme is improved so far retting of the common fibre plants of this country are concerned, its future possibilities are rather remote. Any method as envisaged by the authors, primarily will require retting tanks and complicated system of controlled retting which is hard to visualise on ordinary cultivator growing from 1 to 10 acres of jute or sunnhemp at the utmost, to be able to afford. These common fibre plants of this country are also such which cannot be left long after harvest to be transported to central Retteries as is done with Flax in Europe. Again in Flax, the authors' data do not show any appreciable effect. In table 5, they have shown that linum which is presumed to be Flax, takes 2-3 days, whereas in ordinary water having average temperature of 80°F, 30-48 hours is quite enough.

On the question of cost the authors merely mention "Hiparol appears to be reasonably cheap and easy to handle, (details of which are intended to be published later)." In this connection it may only be observed that controlled methods even if adopted can hardly compete with methods based on natural resources and which is more applicable to a country like India. As an example it can be stated that Bengal's monopoly in jute fibre is mainly due to nature's gift of plenty of retting water when it is actually needed. It is a well known fact that jute can grow well in many other countries, and also

has been grown, but none have been able to compete with Bengal jute in price by whatever methods they may have employed, only because the natural resources are not available there.

E. A. R. BANERJI

Office of the Asst. Fibre Expert,
Bengal, 2-6-1945.

[We sent a copy of the above note to Dr and Mrs. Baruah, to enable them if they so desired to answer the several points of criticism of their previous publication contained in Mr. Banerji's letter. The former have intimated that in view of the detailed report on this subject published by them in the present issue of SCIENCE AND CULTURE, they do not think a separate reply is necessary. —Ed., *Sc. & Cul.*]

DARKENING OF TOMATO JUICE

Under the head "What Scientists are doing" in the July, 1945 issue of the *Indian Farming*, we find a note regarding the prevention of darkening of tomato juice. Two methods have been suggested to prevent the darkening of tomato juice as worked out by the Vegetable Specialist, Lyallpur. In the same note a hint has been thrown regarding some possible relation with the iron content of tomatoes and juice darkening. While the author has nothing to say regarding this point he finds certain drawbacks in the methods suggested to prevent darkening of juice, which are detailed below.

According to the first method suggested, the darkening can be prevented by putting into the bottle at the time of the filling, a thin strip of tin plate equal in length to the height of the juice. The application of this method on a commercial scale, it must be said is impossible. No amount of favourable propaganda would induce the Indian buyer to buy bottles with tin strips sticking in them. Moreover the factories dealing with bottled products will find it difficult and also expensive to obtain strips of tin plate for each bottle of tomato juice. Then one would have to imagine the vast quantity of tin plate required annually for filling 100000 of the 13 oz. bottles of tomato juice. Now taking the second method of keeping the bottles in diffuse light, we find that this is again impossible in practice. Most factories have only underground cellars for storage, in view of the extreme heat of the plains in the summer months. Even assuming the factories providing for proper lighting of the storage rooms, how are the numerous dealers to be induced to adopt such methods.

From his own experience the author feels that the darkening of tomato juice is not such a serious problem and that the darkening is really a result of presence of air, which may be due to leakage after bottling and capping or is a result of imperfect exhaust. It would be worthwhile to carry out investigations on these lines to evolve a really practical method of preventing the darkening on a large scale. Moreover, if the darkening could also be correlated in some way with the iron content of tomato, a way to a practical solution of the difficulty could probably be easily found out.

The author is indebted to Mr K. P. Bhargava, Proprietor, G. G. Fruit Factory, Agra, for kind permission to publish this note.

K. C. BATRA

G. G. Laboratories,
G. G. Fruit Preserving Factory,
Agra, 20-9-1945.

MEASURES OF HETEROGENEITY IN AGRICULTURAL AND SIMILAR FIELDS, AND THEIR INTER-RELATIONS

Harris[1] (1915) proposed the intra-class correlation co-efficient of yields from adjacent areas as a "co-efficient of heterogeneity". Fairfield Smith[2] (1938) thinks that a fertility contour map or his *b*-co-efficient of variance serves the purpose better. Mahalanobis[3] (1944) proposes variance function, correlation function and the number of patches in a contour map for the same purpose.

It can be easily seen that the pattern in a field may be of two qualitatively opposite types, (*a*) homogeneous and (*b*) heterogeneous, with the (*c*) random type, intermediate. There will obviously be quantitative differences also (in relative heterogeneity) among fields belonging to any of the broad types (*a*) or (*b*). We may conventionally call type (*a*) positive, type (*b*) negative and type (*c*) zero, in accordance with the nature of association between neighbouring areas.

It is obvious that all measures of heterogeneity should tally broadly, if not in detail. The relation between variance and correlation being simple, that between correlation and number of patches has been taken up for study. Starting from the simplest case of a linear field with a binomial variate, it can be shown that the serial correlation with unit gap (*i.e.*, for adjacent cells)

$$\rho = 1 - \frac{r}{pq} \quad \ldots\ldots (1)$$

where p is the proportion of any of the binomial characters, $q = 1-p$, and $2r$ is the ratio of number of patches to the number of cells. This relation is strictly true if we convert the linear sequence (or field) into an endless chain by linking the last cell with

the first. For the original field, some correction is necessary which, however, is negligible if the number of patches (or cells) is large.

As soon as we pass over to a multinomial or a two-dimensional field, it can be shown that there can be no such simple and unique relation though there will be broad correspondence.

The sampling distribution of p of equation (1) in case of a *random* arrangement has been worked out. p can assume a set of discrete values between the maximum $1-\frac{1}{Npq}$ and the minimum $1-\frac{1}{p}$ or $1-\frac{1}{q}$ (whichever is greater), changing by equal steps of $\frac{1}{Npq}$, where N is the total number of cells in the endless chain. And the probability of p being equal to $1-\frac{r}{pq}$ is

$$\frac{C_{Np-1}^{N-1} \cdot C_{Nr-1}^{Nq}}{C_{Np}^{N-1}} \equiv \frac{C_{Nr}^{Np} \cdot C_{Nr-1}^{Nq-1}}{C_{Nq}^{N-1}} \quad \ldots\ldots\ldots (2).$$

(The probability for the *minimum* value of p however, is given by a slightly different expression).

If however p itself is subject to sampling fluctuation the *population* probability value being π p can change by steps of $\frac{1}{N}$ from 0 to 1 and the probability of getting p is

$$C_{Np}^{N} \cdot \pi^{Np}(1-\pi)^{Nq} \quad \ldots\ldots\ldots (3).$$

And the probability of getting jointly p and ρ is given by (2) × (3), and the probability for ρ is derived by summation of (2) × (3) over all possible value of ρ

My thanks are due to S. N. Roy for his kind interest. Further theoretical and experimental studies are proceeding.

BIRENDRANATH GHOSH.

Statistical Laboratory
Presidency College,
Calcutta, 4-10-1945.

[1] Harris, *Amer. Nat.*, *49*, 430-54.
[2] Smith, F. *J. Agri. Sc.*, *28*, 1-23.
[3] Mahalanobis, P. C. *Phil. Trans.*, *231B*, 329-451.

THE OPTIMUM RANGE OF TEMPERATURE OF WATER FOR THE FINGERLINGS OF MAJOR-CARPS OF INDIA

It is a general practice to stock fingerlings of carps for rearing purposes. The temperature of different forms of fresh-water varies so much that one must know the maximum and minimum limits of temperature of waters in which the carp fingerlings can thrive. For example, ponds of the railway workshops or watering stations, jute mills and other factories have usually higher temperatures due to the discharge of boilers etc. in the close vicinity whereas hill streams, lakes or ponds on the hill top and ponds in connection with ice-factory or other chemical factory, specially that manufactures chemicals like ammonia etc. have a lower temperature of considerable degrees.

In India the optimum range of temperature suitable for rearing of major carp fingerlings has not yet been determined. Considering its highest significance we set a series of experiments with the usual control to ascertain the effect of maximum and minimum temperatures of water in which the carp fingerlings could thrive.

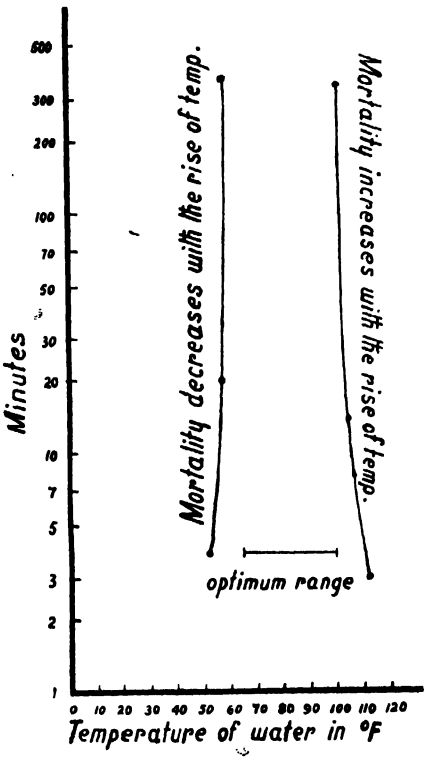


FIG. 1.
Mortality curve. Plotted from the data of the experiment on an arithlog grid.

For ascertaining the highest range of temperature on the life-activity of fishes we kept carp fingerlings of at least half-a-dozen of different size and weight

in different sets in incubators and observed that they could stand the temperature upto 102°F and above which when the temperature was gradually increased they showed a steady decrease in the activity resulting in death. The extreme was reached at 113°F when death occurred within two minutes. Das[1] has shown that similar high temperature causes death in some other fishes.

For ascertaining the lowest temperature we carried the same experiment with carp fingerlings in different sets in refrigerators and it was observed that the fishes could adapt themselves upto 62·6°F and on further decreasing the temperature a steady decrease in the span of their life-activity was marked upto the limit of 57·2°F where they were found to be alive for 15-20 minutes.

On raising the temperature within the limit of 15-20 minutes to a temperature of 62·6°F they could be revived to activity but beyond that limit of 20 minutes they met death. At 53·6°F no fingerlings could survive for more than two minutes.

Though the fry could stand the limits of maximum and minimum temperatures of 102°F and 62·6°F respectively, it was found from another set of experiments that they habitually lose their weight beyond the limits of 100°F and 65°F. Between this range a gradual decrease in weight was also marked.

Thus from the above experiments we conclude that the major carp fingerlings thrive well in the range between 65°F and 100°F if due consideration is taken to provide all sorts of contingencies required for the development of carp fingerlings.

The results of the experiments are given in the graph (Fig. 1) and table below.

TABLE SHOWING THE RESULT OF THE EXPERIMENT PERFORMED TO DETERMINE THE OPTIMUM RANGE OF TEMPERATURE REQUIRED FOR THE REARING OF CARP FINGERLINGS BETWEEN THE SIZE 6·5 MM. AND 7 MM.

Temp. of water	No. of expt.	No. of fish taken in	Kind of fish taken in	Length of fish	Period of expt.	Period of survival	Remarks
53·6 F.	3	8	C. Mrigala .. 3 L. rohita .. 2 C. catla .. 3	7 cm.	12-35 P.M. to 12-39 P.M.	4 mins.	Survival period very short. Temp. unsuitable.
57·2 F.	2	5	C. mrigala .. 4 L. rohita .. 1	7 cm.	4 P.M. to 4-20 P.M.	20 mins.	Survival period increases but due to mortality within 20 mins. temp. unsuitable.
59·2 F.	2	5	C. mrigala .. 2 L. rohita .. 3	7 cm.	12-10 P.M. to 6-30 P.M.	400 mins.	Survival period increases but as mortality takes place temp. is unsuitable.
62·2 F.	2	5	C. mrigala .. 3 L. rohita .. 1 C. catla .. 1	6·5 cm.	11 A.M. to 10-45 A.M.	No mortality	No mortality, but when kept in this temp. for 15 days a decrease in body weight takes place.
65 F.	2	10	C. mrigala .. 3 L. rohita .. 4 C. catla .. 3	6·5 cm.	10-45 A.M. to 10 A.M.	No mortality	No mortality and decrease in weight. Temp. is suitable for growth and maintenance.
100 F.	2	5	C. mrigala .. 2 L. rohita .. 1 C. catla .. 2	7 cm.	11 A.M. to 10 A.M.	No mortality	Do.
102 F.	3	8	C. mrigala .. 2 L. rohita .. 3 C. catla .. 3	6·5 cm.	1 P.M. to 12-30 P.M.	No mortality	Marked decrease in weight was observed when kept in this temp. for 15 days.
103 F.	2	5	C. mrigala .. 1 L. rohita .. 1 C. catla .. 3	7 cm.	1-30 P.M. to 7-45 P.M.	375 mins.	Mortality begins at this temperature.
104 F.	2	5	C. mrigala .. 2 L. rohita .. 3	7 cm.	4-50 P.M. to 5-5 P.M.	15 mins.	Survival period decreases.
107 F.	3	8	C. mrigala .. 2 L. rohita .. 5 C. catla .. 1	7 cm.	2-35 P.M. to 2-43 P.M.	8 mins.	Survival period decreases rapidly.
113 F.	2	5	C. mrigala .. 2 L. rohita .. 3	6·5 cm.	2-12 P.M. to 2-14 P.M.	2 mins.	Survival period very short.

Zoology Dept.,
University of Calcutta,
Calcutta, 9-10-1945.

H. K. MOOKERJEE
D. N. GANGULY
S. N. SEN GUPTA

[1] Das, A. K., Lethal temperature of some air-breathing and non-air-breathing fishes of India, SCIENCE AND CULTURE, *11*, 164, 1945.

CONDENSATION OF PARA-AMINOPHENYLSTIBINIC ACID WITH UREA

It is quite well known that Urea Stibamine, a potent drug introduced by Brahmachari in the year 1922 for the treatment of Kala-azar, is formed by interaction of *p*-aminophenylstibinic acid with urea. In course of our researches[1] on this drug, certain new observations with regard to the above reaction have now been made, which throw some light on the factors influencing the preparation of this important drug.

p-aminophenylstibinic acid (Stibanilic acid), prepared by the usual hydrolysis of *p*-acetylaminophenylstibinic acid, has now been purified by dissolving the acid in the requisite quantity of cold, $\frac{N}{4}$ Hydrochloric acid, filtering and then precipitating with sodium acetate. This purification has been carried out twice and any acetyl compound, which remained as an impurity being mixed up with stibanilic acid, has been completely eliminated. When this pure stibanilic acid is employed for the condensation with excess of urea under the usual experimental conditions, which consist in heating the ingredients in presence of water at 80° on the water-bath for about 2 hours, only a small quantity of stibanilic acid is found to take part in the reaction, leaving the rest in an insoluble state. On prolonged heating, a clear solution is no doubt obtained, which ultimately yields Urea Stibamine, but due to this prolonged heating there is more formation of antimonious and antimonic acids than usually found. The product, thus obtained, has been found more toxic than usual, probably due to the presence of more quantities of antimonious and antimonic acids.[1] But, if urea is added to a mixture of pure stibanilic acid (15 g.) and pure *p*-acetylaminophenylstibinic acid (0·5 g.), suspended in water, and the mixture shaken for about 30 minutes, a clear solution is obtained and the usual reaction takes place when the solution is heated at 80° for about 2 hours, resulting ultimately in the formation of Urea Stibamine of practically standard quality.

When this pure acetyl compound is treated at room temperature with excess of urea in presence of water, within a few minutes a clear solution is obtained in shaking. When this clear solution is heated at 70° or allowed to stay for some hours at room temperature, it tends to become viscous and when poured into large volume of alcohol, no condensation product was, however, obtained.

The above observations indicate that *p*-acetylaminophenylstibinic acid forms a loose salt with urea, which is readily soluble in water. Although pure stibanilic acid, at room temperature, does not go into solution in water containing excess of urea, the presence of a slight trace of the acetyl compound facilitates the formation of a clear solution. Because of the formation of this clear solution, stibanilic acid and urea are brought together within the sphere of reaction and the usual condensation readily takes place with the formation of the drug, Urea Stibamine. This role of *p*-acetylaminophenylstibinic acid is rather remarkable and the ease with which commercial stibanilic acid reacts with urea is attributed to the presence of traces of the acetyl compound.

S. Datta
T. N. Ghosh
A. N. Bose

Indian Research Institute Laboratory,
Indian Research Institute Ltd.,
Calcutta, 22-10-1945.

[1] Datta, Ghosh and Bose, Science and Culture, *11*, 142, 1945-46.

SUBSTITUTED AMIDES OF DIPHENYLAMIN-4:4′-DISULPHONIC ACID

In the sulpha-series, compounds with two *p*-sulphonamidophenyl nuclei linked through -NH- group have not been synthesised so far. With a view to testing their bactericidal properties, a few such compounds have now been synthesised.

Merz and Weith[1] as also Gnehm and Werdenberg,[2] prepared diphenylamin-4:4′-disulphonic acid and a few other derivatives. The disulpho-chloride and disulphonamides reported here have not been prepared before.

The action of PCl_5 on diphenylamin-4:4′-disulphonic acid yielded a dark pasty product which decomposed during purification and also on standing. This unstable product has been proved to be the disulphochloride from its behaviour towards ammonia and aromatic amines. On reacting the non-purified disulphochloride (obtained after freeing it from $POCl_3$) with ammonia, aniline, *o*-, *m*-, and *p*- toluidines, *o*-, *m*-, and *p*- xylidines, *o*-, and *p*- anisidines and *p*-aminophenol, the corresponding substituted disulphonamides tabulated below were obtained. All these compounds are easily soluble in alkali and insoluble in mineral acids.

No.	Compound	m.p.
I.	$NH(C_6H_4.SO_2.NH_2)_2$	... 136—137°
II.	$NH(C_6H_4.SO_2.NH.C_6H_5)_2$	170°
III.	$NH(C_6H_4.SO_2.NH.C_6H_4.CH_3$-ortho$)_2$...	210°
IV.	$NH(C_6H_4.SO_2NH.C_6H_4.CH_3$-meta$)_2$...	205°
V.	$NH(C_6H_4.SO_2NH.C_6H_4.CH_3$-para$)_2$...	240°
VI.	$NH(C_6H_4.SO_2.NH.C_6H_3.(CH_3)_2$-ortho$)_2$...	230°
VII.	$NH(C_6H_4.SO_2.NH.C_6H_3.(CH_3)_2$-meta$)_2$...	175°

Compound	m.p.
$NH(C_6H_4.SO_2.NH.C_6H_3.(CH_3)_2\text{-para})_2$	220°
$NH(C_6H_4\text{-}SO_2.NH.C_6H_4.OCH_3\text{-ortho})_2$	230°
$NH(C_6H_4\text{-}SO_2.NH.C_6H_4.OCH_3\text{-para})_2$	140°
$NH(C_6H_4\text{-}SO_2.NH.C_6H_4.OH\text{-para})_2)$	180°

Further work including the preparation of 4 : 4′-disulphonamidodiphenyl hydrazine is in progress.

R. T. Thampi
B. H. Iyer
P. C. Guha

Organic Chemistry Laboratories,
Indian Institute of Science,
Bangalore, 23-11-1945.

[1] Merz and Weith, *Ber.*, *5*, 283, 1872; *6*, 1513, 1873.
[2] Gnehm and Werdenberg, *Z. Ang.*, *12*, 1053, 1899.

NATURE OF THE 'ACTIVE SUBSTANCE' PRESENT IN THE CONTACTILE TISSUES OF SOME OF THE HIGHER PLANTS

The nature of the motility exhibited by many plant organs has been subject of a large number of investigations since the time of Darwin. Our knowledge of the chemical basis of motility of the flagella in the unicellular alga *Chlamydomonas eugamatos* has been placed on a new basis by the important investigations of Moewus[1] *et al.* These investigations have shown that the chemical substances responsible for motility, gametic union and sex determination in this alga are intimately related to each other ; they all belong to the carotenoid group of compounds, and are supposed to be derived from a parent substance termed protocrocin. Thus the motility depends upon the presence of crocin a digentiobiose compound of crocetin, the active substances necessary for gametic union are the *cis* and *trans* dimethyl esters of crocetin. The sex determining substances called termones are replaceable by picrocrocin and safranal.

Sir J. C. Bose made a series of extensive investigations on a number of higher plants with motile pulvinated organs like *Mimosa, Biophytum, Desmodium* etc. In one of his last books 'Motor Mechanism in Plants' (1928) Bose discusses the possible chemical basis for the motility of these plant organs. He found that the intensity of motor response *i.e.*, the rate and extent of contraction of the pulvinus is dependent upon (*i*) the supply of oxygen to the plant, (*ii*) on the tonic condition of the plant and (*iii*) on some specific property of the motor organ which varies with the nature of the plant. He distinguishes between three types of pulvini as 'Active', 'Semi-active' and 'Inactive'. *Mimosa pudica* is representative of the first *Neptuna* of the second and *Erythrina* of the third.

By using different methods of staining, Bose showed that it was possible to distinguish between the active cortical cells of the pulvinus from the inactive cells of the petiole ; while the former are stainable, the latter remain unstained. It was noticed by him that the density of distribution of the granular active substance in the cell protoplasm of the pulvinus varied with the rapidity of contraction of the pulvinus, being most dense in *Mimosa pudica.* Different microchemical tests applied to these pulvini showed that the activity of the modified protoplasm was due to the presence of a highly reactive and oxidisable substance which is an unsaturated carbon compound with double or triple bond combinations ; this substance is neither a fat nor a lipoid.

In view of the results obtained by Moewus *et. al.* it appeared worth while to investigate whether the unsaturated carbon compound found in the active pulvinus by Bose belonged to the carotenoid group, which all contain conjugated double bonds. Mr Amiya Adhikari was entrusted with repeating Bose's investigations with different stains. Having confirmed the previous results, Adhikari employed Molisch's carotene test[2] (Test 1) to locate the presence of carotenoid compounds in the active pulvini of the different plants investigated by Bose. Surprisingly large amounts of carotene crystals were found in the primary and secondary pulvini of *Mimosa pudica.* It was also noticed that the density of distribution of carotene crystals in the active cells of the several plant pulvini followed roughly the same order of distribution as found by Bose with his staining methods. These results were independently verified by Mr B. K. Palit one of the senior workers of the Institute from the time when Prof. Molisch was a guest worker in the Institute (1928-29). Molisch's Test I does not however reveal the exact nature of these carotenoid compounds. B. Banerji of the Biochemical Department undertook this portion of investigation. The method employed was that used by Willstätter and Stoll[4] for the isolation of carotene and xanthophyll as subsidiary substances present with chlorophyll. The final crystalline products obtained were examined under a microscope and found to be similar to the photographs of crocetin crystals given in Zechmeister' monograph[5] (plate 59, *a* & *d*).

At this time it was reported by B. K. Palit and other senior workers of the Institute that Prof. Molisch had tested sections of the active pulvini with sulphuric acid solutions of *p*-dimethyl amino benzaldehyde (Solution 2). The latter according to Molisch[3] was a very sensitive test for the detection of the presence of Pholoroglucine, giving an intense red colour. Molisch found that all these active pulvini gave this characteristic red colour when treated with solution 2, from which he concluded that the unsaturated carbon compounds inferred by Bose

to be present in the motile pulvini to be Phloroglykotannoide *i.e.*, compounds of phloroglucin with tannic acids. Molisch's investigations with solution 2 were repeated by B. Banerji and G. Bhattacharya. The latter noticed that besides the deep red coloration of pulvini sections as found by Molisch, an additional reaction took place *viz.*, from the treated section of the pulvini an orange coloured liquid flowed out from which crystals identical in colour and shape to crystals of *trans* crocetin dimethyl ester, isolated from Indian Saffron by Banerji, were observed. Formation of similar crystals in sections of pulvini of *Neptunia*, *M. Spegazzinni* and *Desmodium gyrans* were observed when treated in *situ* with solution 2. Identical crystals were also obtained when on a microscopic slide crocin isolated from Indian Saffron was treated with solution 2. On the other hand when the same solution 2 was added to glucose, sucrose and other higher sugar molecules, the formation of orange yellow crystals was not observed.

It appears that crocin or similar glycoside compounds of crocetin are present in the motile plant pulvini and the following chemical reaction is responsible for the appearance of orange yellow crystals *viz.*, the two glycoside molecules (similar to gentiobiose) attached to crocetin in crocin like substances suffer acid hydrolysis when treated with solution 2, and are then replaced by two methyl groups from *p*-dimethylaminobenzaldehyde molecule to form *trans* crocetin dimethyl ester which crystallise out from the reacting solutions.

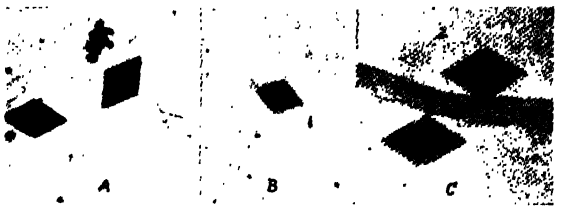


FIG. 1. Microphotographs *of trans* crocetin dimethyl ester crystals (magnification 56) (*A*) isolated from saffron, (*B*) formed in *vitro* by action of solution 2 on crocin isolated from saffron and (*C*) formed in *situ* by addition of solution 2 to a section of pulvinus of M. pudica. The faint appearance of the crystals in (*C*) is due to faulty exposure.

In Fig. 1, microphotographs of crystals, all orange yellow in colour and rhombic in shape are reproduced representing crystals of *trans* crocetin dimethyl ester, (*A*) isolated from Saffron, (*B*) formed in *vitro* by the action of solution 2 on crocin isolated from Saffron and (*C*) formed in *situ* by the addition of solution 2 to a section of pulvinus of *M. pudica*.

Thus it is reasonable to infer, (*i*) that Molisch's solution 2 is a suitable reagent for in *situ* detection in plant organs of crocin or similar glycoside compounds of crocetin and (*ii*) that such glycosides are present in the active pulvini of motile plants and they are probably identical with the unsaturated carbon compounds detected in them by Sir J. C. Bose and designated by him as 'active substance'. The detection of crocin or similar glycoside compounds in motile plant organs represent an important extension of the observation of Kuhn and Moewus of the presence of similar compounds in several species of Chlamydomonas with motile flagella. The presence of four glucose molecules in each molecule of crocin suggests that the latter is responsible for the supply of energy required for mechanical work, by dismutation of glucose molecules. It is not clear what is the role of the crocetin rest in this process. Kuhn and Moewus, from a study of the ratio of occurrence of *cis* and *trans* crocetin dimethyl ester molecules in males and females in different species of Chlamydomonas, which roughly follow the ratio of Bergmann-Niemann numbers of the occurrence of amino acids in protein molecules *viz.*, $3^m \times 3^n$ where m, n can have values, 0, 1, 2, 3, etc. have suggested the hypothesis that these crocetin compounds act as prosthetic groups which are attached to amino acids of certain enzymes. From this it may be inferred that probably the glucose molecules in the substrate crocin during dismutation become attached to the corresponding enzyme through the crocetin rest molecule. It is known that the maximum phototropic effect occur in plants, with or without chlorophyll, in the region of maximum light absorption by carotenoid compounds.

B. BANERJI
G. BHATTACHARYA
D. M. BOSE

Bose Institute,
Calcutta, 1-12-1945.

[1] Sonneborn, T. M., Sex hormones in Unicellular Organisms. *Cold Spring Harbour Symp., 10*, 111, 1942.
[2] Molisch, H., *Microchemie der Pflanze*, p. 250, 1921.
[3] — — — — *ibid.*, p. 146.
[4] Zechmeister, Z. Handbuch der Pflanzenanalyse, edited by G. Klein. Bd. III, Part 2 : II, p. 1278.
[5] — ——— —— *ibid.*

A NEW CLASSICAL THEORY OF PHOTON AND ELECTRON

(Preliminary Report)

A little critical examination shows that the Einstein equation $W = h\nu$ associating a quantum of energy $h\nu$ with every electro-magnetic waves of frequency ν cannot be universally true, but must be regarded as an over-generalisation. Otherwise, the breadth of the spectral lines and the continuous spectra would make the energy of radiation of a finite mass of excited atoms infinite.

Starting from the Maxwell equations it can be shown that a linear photon which presents the Doppler Effect and is otherwise invariant against the Lorentz Transformation must have an equation of the form $E_y = H_z = A \sin k\,(x-ct)/(x-ct)$, the other electric and magnetic components being zero. We restrict these forces to act only on points on the x—axis, the path of the photon. The volume integral giving the Energy reduces to a line integral on the assumption of the existence of a limit and we get the Energy $h\nu$ and the Impulse $h\nu/c$.

Further it can be shown that the complete photon $A \sin K\xi/\xi = A \int_0^K \cos K\xi\, dk$, $(\xi = x-ct)$ may split up into a photon of lesser energy $A \sin K_1\xi/\xi$ and a partial photon $A\,(\sin K\xi - \sin K_1\xi)/\xi$ of energy $h\,(\nu-\nu_1)$.

In particular when $K-K_1 = \delta k$ is small and ξ not too large, the latter reduces to $A\,\delta K \cos K\xi$ which represents a train of simple harmonic waves of energy proportional to δK. This marks a departure from the classical as well as the Quantum theory and gives a satisfactory picture of the fading away of a beam of light.

Again if the amplitude $A\,\delta K$ is halved, the energy is also halved while the phase remains sensibly unaltered. This gives a complete picture of the process followed in producing Interference fringes by splitting up a beam into two portions, retarding one and making them come together again. The demands of physical optics are therefore satisfied.

The particle characteristics of light are therefore due to the complete photon, while the wave characteristics are due to partial photons of small energy. The present controversy about the wave and particle nature of light is therefore settled.

An electron is conceived as a photon arranged in coils along the parallels of latitude on a sphere. The Maxwell equations are satisfied. This agrees with de Broglie's theory and the Coulomb law follows as a matter of elementary geometry. We get a plausible figure for the electronic charge and the electronic radius is of order 10^{-11} against the classical figure of 2×10^{-13} based on the now discarded theory of mass of moving electric charges.

The Doppler Effect, longitudinal and transverse, gives the relativity variation of mass.

The Bohr theory of atomic spectra is based on the Newtonian Potential which has not got the sanction of the Relativity Theory. On the present theory, the radiation of energy from the corpus of the electron itself seems generally to be more in accordance with the Relativity Theory.

16, Palm Avenue, Ballygunge,
Calcutta, 3-12-1945. B. M. SEN

APPLICATION OF X-RAY DIFFRACTION METHOD IN THE ANALYSIS OF AN ORE FROM RAJPUTANA

X-RAY powder photographs has not been used extensively for the identification of minerals, although it is a powerful method for identifying a mineral unambiguously in many cases where an ore is suspected to contain minerals of identical chemical compositions but having different crystalline structures. Recently a small quantity of an Uranium containing ore from some unknown locality was given to us for analysis. From a thorough chemical and spectrographic analysis it has been found that the ore contains a inner core of pitch blende having the sp. gr. 6.96 and hardness 5·5. In the outermost coating there is a lemon-yellow mineral which has been identified to be Uranophane. The layer adjacent to pitch blende is an orange-yellow mineral of sp. gr. 5·64 and hardness 3. The partial composition of this mineral has been reported in an earlier communication by Chatterjee and Sarkar,[1] Gummite is the first alteration product of pitch blende and uranophane is the next stage. From the chemical analysis it was not possible to establish definitely whether this mineral was Gummite or Clarkite. To decide this point X-ray powder photograph of this orange-yellow mineral was taken.

From a comparison of the spacings obtained and the corresponding estimated intensities with those of gummite and clarkite as determined by Ross, Henderson and Posjnak[2] it could easily be concluded that the mineral in question is gummite. The most conclusive evidence against the existence of clarkite in the sample is the absence of a very strong line having spacing 5·9 A.U. observed by Ross, Henderson and Posjnak. In the photograph of the present sample the presence of two strong lines of spacings 3·5 A.U. and 3·18 A.U. in agreement with the observations on gummite by Ross, Henderson and Posjnak is another particularly convincing reason for our conclusion. The intensities and spacings of the other lines observed in the X-ray diffraction photograph of the present sample agrees in general within experimental error with those of gummite.

Our thanks are due to Prof. K. Banerjee for providing facilities for the X-ray work in the laboratories of the Indian Association for the Cultivation of Science.

P. B. SARKAR
R. K. SEN
University College of Science and Technology,
92, Upper Circular Road, Calcutta, and
Indian Association for the
Cultivation of Science,
210, Bowbazar Street, Calcutta.

[1] Chatterjee & Sarkar, SCIENCE AND CULTURE, *9*, 560, 1943-44.
[2] Ross, Henderson and Posjnak, *Amer. Minerologist*, *16*, 213, 1931.

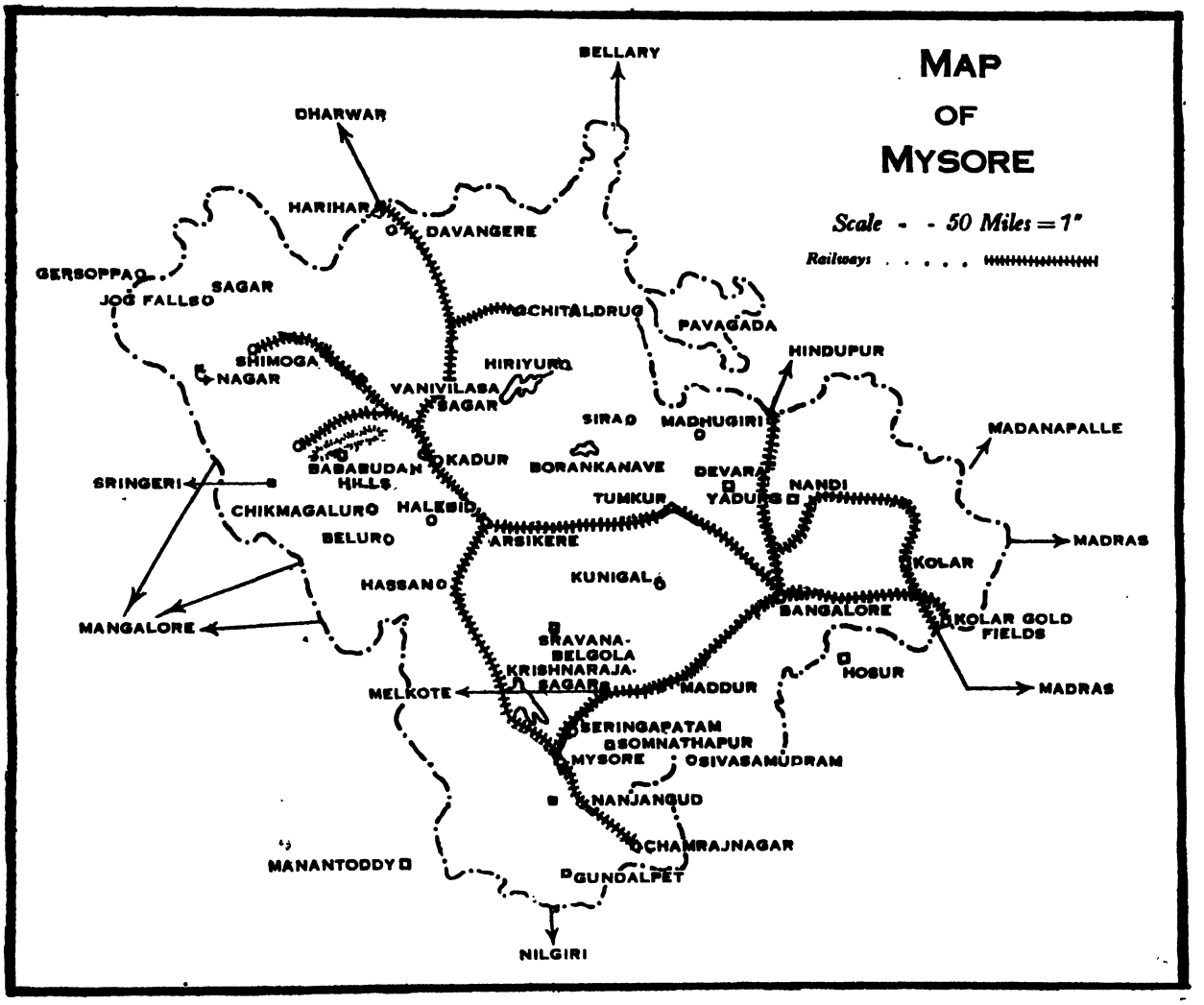
BANGALORE

B. H. IYER,

DEPARTMENT OF ORGANIC CHEMISTRY, INDIAN INSTITUTE OF SCIENCE, BANGALORE

BANGALORE, the venue of the 33rd Session of the Indian Science Congress Association, is the principal city in the Mysore State and the Headquarters of the Government of Mysore. Founded in the 17th century by the Yelahanka Chief, Kempe Gowda, the area round the historical fort of Bangalore formed the base of the present City of Bangalore. It covers an area of nearly 25 sq. miles and consists of two separate but adjacent parts, the city proper and the civil and military station, the latter being administered by the British Resident in Mysore. Situated at the centre of a table-land, about 3,000 feet above the sea level, and endowed with a salubrious climate all the year round, Bangalore has attracted a large number of settlers and developed into a very important industrial and commercial centre in the south.

Mysore State, with an area of 29,458 sq. miles,



is a table-land situated in the angle formed by the Eastern and Western Ghats, before they converge into the Nilgiri Hills. The general elevation rises from about 2,000 feet above the sea level along the northern and southern frontiers to about 3,000 feet at the central watershed which separates the basin of the Krishna in the north from that of the Cauvery in the south. The City of Mysore is the ceremonial capital of the State, being the residence of His Highness the Maharaja. The State has a population of over seven millions, nearly three-fourths of which are employed on agriculture.

During the past half a century and more, the Mysore State, under the guidance of her noble and benign rulers and able and illustrious dewans, has made such rapid progress in administrative reforms,



C. Rangacharlu, C.I.E., Dewan (1881-1883)



Rajyadhurandhara Sir K. Seshadri Iyer, K.C.S.I., Dewan (1883-1901)



Dr. Sir M. Visvesvaraya, K.C.I.E., Dewan (1912-18)



Amin-ul-Mulk Sir Mirza M. Ismail, K.C.I.E., O.B.E., Dewan (1926-41)

education, industry and commerce, and in providing civic amenities and in rural uplift, that she has deservedly been styled as the "Model State" in India. The present Maharaja, His Highness Sri Jayachamaraja Wadiyar Bahadur, G.C.S.I. ascended the throne in 1940.

Administration

His Highness the Maharaja is the ultimate authority in the State and the administration is conducted under his control by the dewan and the ministers. The High Court is the highest judicial tribunal in the State. There are two constitutional Houses: (1) The Representative Assembly and (2) the Legislative Council. The administration report for 1943-44 records that the total receipts under various heads of revenue reached the figure of Rs. 857·28 lakhs. Mysore's all round progress is evident from the fact that "between 1939-40 and the budget year 1945-46, the expenditure on education has risen from Rs. 54 lakhs to Rs. 111 lakhs, on medical relief from Rs. 16 lakhs to Rs. 29 lakhs, on public health from Rs. 2 lakhs to Rs. 8 lakhs, on agriculture from Rs. 5 lakhs to Rs. 8 lakhs, on veterinary services from Rs. 4 lakhs to Rs. 8 lakhs, and on sericulture from Rs. 1 lakh to Rs. 4 lakhs."

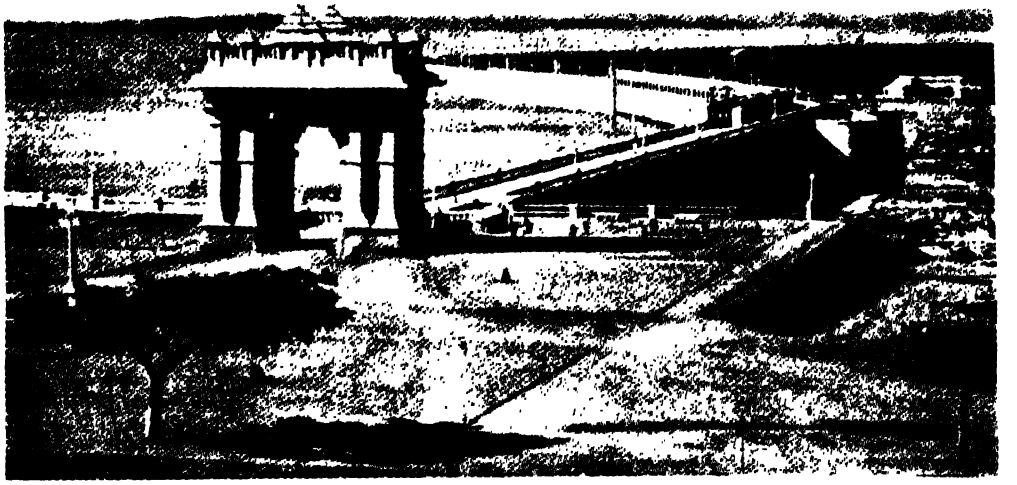
Mysore University

The Mysore University which is of the teaching and residential type was established in 1916. This is the first University to be founded in the Indian States. The University which is mainly State-supported comprises the Central College, Engineering College, and Maharani's College for Women, at Bangalore, the Medical, Maharaja's and Teachers' Training Colleges at Mysore and a number of Intermediate Colleges. Within its ambit are included the medical and engineering schools at Bangalore. The University imparts education in all branches of arts and science leading both to graduate and post-graduate degrees. Within the University there is a vigorous school of research carrying investigations in the fields of chemistry, geology, physics and mathematics, as also botany and zoology.

The Sri Chamarajendra Technical Institute in Mysore and the Sri Krishnarajendra Silver Jubilee Technological Institute and the Sri Jayachamrajendra Occupational Institute in Bangalore afford facilities for training in technology and craftsmanship.

Agriculture in Mysore

Out of the 6·6 million acres of land under cultivation, 1·1 million acres are irrigated by canals, tanks, wells and other sources. The Irwin Canal, the result of a major irrigation scheme, has enabled a vast area to be brought under cultivation. The Krishnarajasagar Dam in Mysore, which helps to conserve the water supply of the State, is 124 feet in height and is the third biggest dam in the world, after Sennar (Sudan) and Assuan (Egypt) dams. Her



KRISHNARAJASAGAR DAM

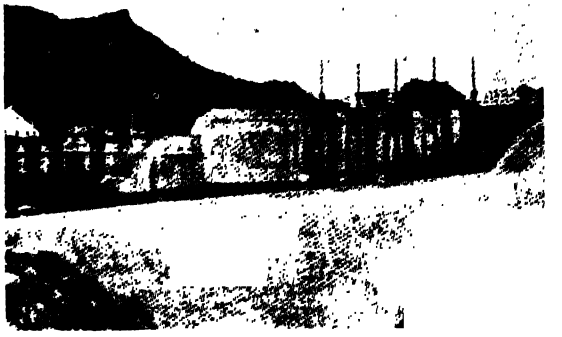
crops include ragi, rice, cholam and wheat ; coffee, sugarcane, cotton and tobacco ; gingelly, groundnut, cocoanut and castor ; pepper, ginger, turmeric and arecanut. Mysore grows a variety of fruits and vegetables.

Veterinary and Livestock in Mysore

The development of agriculture and animal husbandry has assumed such a great importance in the State that the Veterinary and Livestock Sections which were so long under the Agricultural Department have been separated and placed in charge of a Superintendent of Veterinary Services and Animal Husbandry. Serum Institute, poultry, sheep-breeding, bee-keeping, fisheries, dairying, etc., are included under this new Department. The Imperial Dairy Institute in Bangalore has already become a very important centre for dairy research in India.

Electricity in Mysore

Mysore took the lead in the development of the hydro-electric resources in India. In 1902 the Sivasamudram Power Station was established with an initial production of 6000 K.W. With increasing demands for this new power, the Station's capacity was stepped up in stages to 45,000 K.W. The completion of the Shimsa Project in 1940 to generate 20,000 K.W. marks the second stage of hydro-electric development in Mysore. The third definite



SIVASAMUDRAM Intake Work

stage in this direction has been the inauguration of the Jog Scheme for harnessing the highest water fall (Jog Falls) in the world with its drop of 830 feet, at Gersoppa, designed to generate 48,000 K.W. at



SIVASAMUDRAM—The Northern Waterfalls of the River Cauvery



THE FALLS OF THE SHARAVATI RIVER (JOG FALLS)

the first stage, then 120,000 K.W. and ultimately 200,000 K.W. When the plans are completed, Mysore will have 250—300 units of electrical energy per capita of her population per year which may be compared to the figure of 9 for British India. Even now the figure is about 60.

Mining and Mineral exploitation in Mysore

Minerals like gold, silver, iron, chromite, magnesite, monazite, ferrugious bauxite, soapstone, mica and manganese, corundum, porphyry and felspar occur in plenty. As early as 1880 gold mining was started in the Mysore State. The Gold Fields at Kolar contain some of the deepest gold mines in the world, producing almost the entire output of the precious metal in India. Over 20 million ounces of gold, valued at over £102 millions, have been produced from the gold fields since the commencement of the mining operations to the end of 1943. The Mysore Geological Department which has just completed fifty years of useful service to the State has earned unstinted appreciation from scientific circles and also helped to develop the mineral industries of the State. The Mysore Iron and Steel Works and the Cement Plant at Bhadravati, the Government Porcelain Factory at Bangalore, the Dichromate Factory at Belagula and several other similar mineral industries in the State all owe their existence, directly or indirectly, to the results of investigations conducted by this Department.

Industries in Mysore

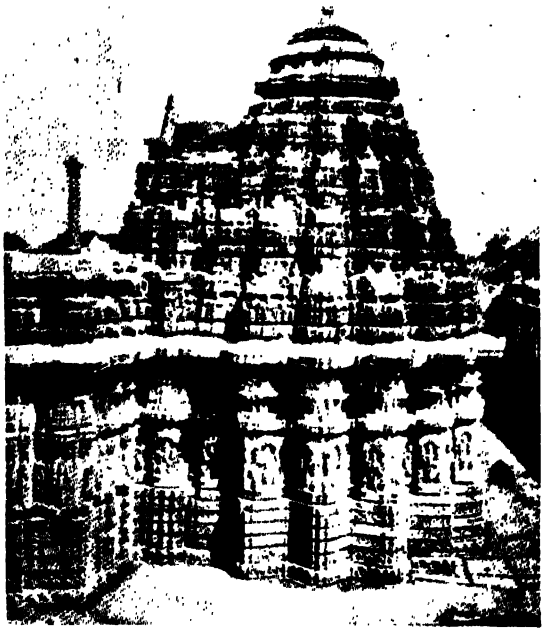
The industrial policy in Mysore was first adumbrated by the late Dewan Ranga Charlu to the newly formed Representative Assembly in 1881. He said:

"The old idea that India must confine itself to agricultural produce is giving way to the more correct theory that no country can prosper unless its agricultural and manufacturing industries were equally fostered. The ordinary routine of the administration of the Government is not the only subject which requires our notice. The development of the various industries on which the prosperity of the country is dependent equally demands our consideration and His Highness' Government will be always prepared to give every attention to any suggestion which may be made upon these subjects."

The pursuit of the progressive industrial outlook has been accelerated by the availability of a variety of raw materials in plenty within the State. There are factories for the manufacture of soaps, sugar, cement and paper. Sandalwood oil industry is a speciality of the State. Another group of factories produces chemicals and fertilizers, drugs and medicines, bakelite articles and lacquerware, stoneware and porcelain goods, insulators, transformers, batteries, switches and other electrical goods. There are now 605 large industrial establishments in the State, employing over 77,000 persons.

It is another corner stone in the industrial expansion of Mysore that the Government contemplate to develop electro-chemical industries in the near future.

The important factories in Bangalore are the Government Soap Factory, Electric Factory, Porcelain Factory and Silk Factory; the Mysore Lamp Works, Glass Works, Amco Factory for Batteries, the Industrial and Testing Laboratory, the Bangalore Cotton and Woollen Mills, the Maharaja Mills, Mysore Vegetable Oil Products Company and the Hindustan Air Craft Factory. It has also been decided to establish a Radio Factory at Bangalore at an early date.



SOMANATHPUR—One of the Stellate Towers

Some of the major factories in the other parts of the State are the Mysore Sugar Company and Distillery at Mandya; the Sandal Wood Oil Factory, the Lac and Paint Works and the Krishnarajendra Mills at Mysore; the Mysore Chemicals and Fertilizers and the Dichromate Factory at Belagula and the Iron Works, Cement Works and the Paper Mills at Bhadravati. The Bhadravati Iron Works are the only works of their kind in the East and possess the biggest wood distillation plant in the British Empire. The Mysore Sandal Oil Factory is the biggest sandal oil manufacturing concern in the world.

A Board of Scientific and Industrial Research, with Sir J. C. Ghosh, Kt., D.Sc., F.N.I., as non-

official Chairman, has been instituted in the State. The aims and objects of this Board are to widen the scope of industrial research and investigations which are of vital importance to the State industries and to maintain close and effective liaison with the Board of Scientific and Industrial Research of the Government of India. Efforts are being made to establish a Central Research Laboratory in the State.

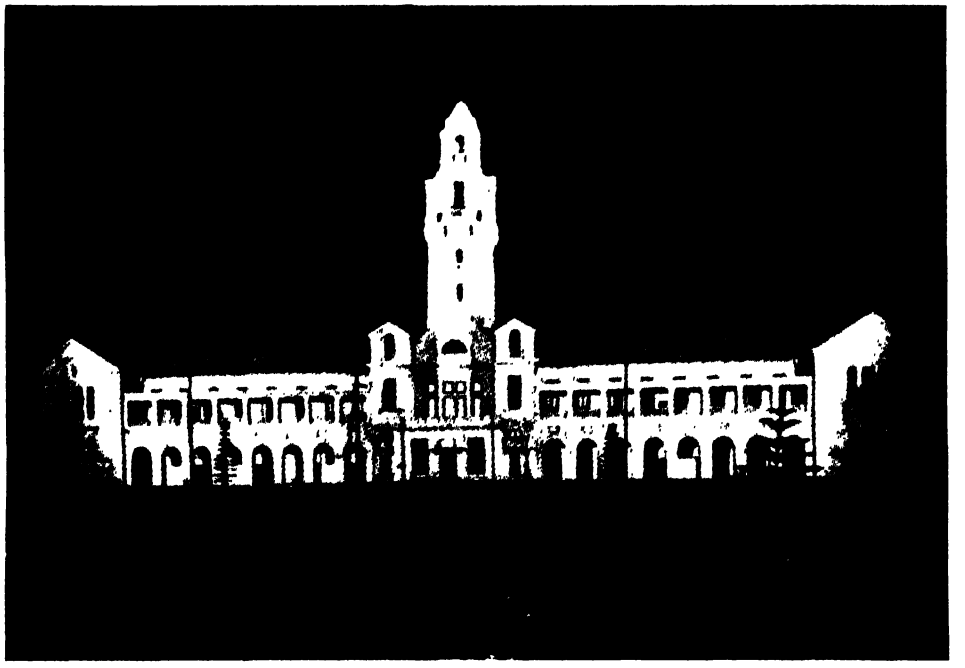
Indian Institute of Science

The Indian Institute of Science, founded by the late Mr Jamsetji Nusservanji Tata, in co-operation with the Governments of India and Mysore, commenced functioning in 1911 with the four Departments of General Chemistry, Organic Chemistry, Applied Chemistry and Electrical Technology. With the progress of time the following additions have been made: Department of Bio-chemistry in 1921, Department of Radio Communication (attached to Department of Electrical Technology) in 1927, Department of Physics in 1933, Sections of Pharmacology, Chemical Engineering and Fermentation Technology in 1940, 1941 and 1942 respectively, and the Department of Aeronautical Engineering in 1942. The Departments of Metallurgy and Internal Combustion Engineering have been added this year, to which students will be admitted from July 1946. Plans for the establishment of a post-graduate Power Technology College are on the way.

Up to 1919-20 the annual income of the Institute was ranging from Rs. 3·24 lakhs to Rs. 3·81 lakhs and the expenditure from Rs. 1·86 lakhs to Rs. 3·41 lakhs. During the period 1919-1939, the average income and expenditure remained practically stationary at about Rs. 6 lakhs. From 1939, since Sir J. C. Ghosh took charge of the Institute as Director, there has been a steady increase in income and expenditure because of various schemes financed by the Council of Scientific and Industrial Research, Department of Supply, Department of Food, Imperial Council of Agricultural Research, Madras and Mysore Governments, being conducted at the Institute and opening of new departments. The budget estimate of income and expenditure for 1945-46 stands at Rs. 19·11 lakhs and Rs. 22·31 lakhs respectively.

Though the Institute is an all India body, it has played an important rôle in the renaissance of the Industrial Mysore. The genesis of a number of important industries in the State may be traced to the preliminary investigations carried out in the laboratories of the Institute.

In addition to the considerable amount of important contributions to pure research, much attention has been paid in recent years to industrial research. Some of the recent achievements in industrial research



INDIAN INSTITUTE OF SCIENCE

have been :—(1) manufacture of formaldehyde from methyl alcohol ; (2) manufacture of nitrobenzene, aniline and dimethylaniline ; (3) manufacture of phosphorus from phosphatic nodules of Trichinopoly ; (4) purification of graphite ores and preparation of graphite lubricants ; (5) manufacture of compressed yeast ; (6) utilization of iron pyrites ; (7) manufacture of titanium oxide from ilmenite ; (8) production of penicillin ; (9) manufacture of varnishes and enamels from cashew shell oil and castor oil ; (10) manufacture of rubber-lined equipment for chemical industries ; (11) manufacture of vitamin D ; and (12) production of pre-digested food.

In aid of war effort, a very large amount of work was carried out in the Institute on behalf of the Army authorities and the Government. A few of the important contributions are mentioned here: (1) On a request by the Air Headquarters, a factory was put up within the premises of the Institute for the manufacture of hydrogen gas on a large scale. The equipment was designed and fabricated by the technical staff of the Institute. (2) Pilot plant experiments have been carried out on processes for the manufacture of potassium-chlorate, urea and white phosphorus as also of malt and vitamin D. (3) Large quantities of rennet powder, depolymerized shellac, carbon composition resistors and vitreous enamelled resistors, 2000 lbs. of the dye-*p*-nitrophenyl-azo-beta-naphthylamine, and over a million ampoules of pituitary extract were manufactured and supplied. (4) A scheme of repairs, tests and calibration of electrical and radio instruments as well as construction and repairs of mechanical appliances were undertaken for the R. A. F. and other fighting services.

Conclusion

Other attractions of the State are the Dasara Festivities at Mysore, the Brindavan Gardens, the Khedda Operations and the several places of religious and historical importance.

Such a short note can only be very sketchy. Therefore, it is thought fit to conclude with two quotations which would speak for themselves about this "Land of Gold, Sandal Wood and Silk".

A speaker at a Mysore Dinner in London said :

"The State is there, open as a book, that he who runs may read. And he who walks may read better than he who runs, and he who rests a while by the way-side will find that it profits him both in body and soul. And he who comes to settle among us can verify the truth of the statement made by a French historian as long ago as the year 1800 that 'the plains of Mysore afford the most beautiful habitation that nature has to offer to mankind upon the earth'."

Knapp's Annual of the East, 1938, London, records :

"The progress of Mysore should be an eye-opener not only to the other States but also to British Provinces, and Mysore should be a place of pilgrimage for all who wish to study and learn."

SHORT LIFE SKETCHES
OF THE
General President and Sectional Presidents

MOHAMMAD AFZAL HUSAIN

General President

Prof. M. Afzal Husain was born in 1889 at Batala in the Punjab. He had his education at the Government College, Lahore, and graduated in Science (with Honours in Zoology) from the Univer-



sity of the Punjab in 1911 and passed the Master of Science examination from the same University in Zoology in 1913. He was a prizeman of his College (1912 and 1913) and an Alfred Patiala Research Student of the University (1911-12). He went to the University of Cambridge for further studies and joined the Christ's College—where his elder brother, Sir Fazl-i-Husain had been a Scholar previously. Prof. Afzal Husain took both parts of Natural Science Tripos. For Part I he took up Botany, Physiology and Zoology and he obtained First Class Honours in Part II of the Tripos in Zoology. Prof. Afzal Husain was a prizeman, Foundation Scholar and Bachelor Scholar of the Christ's College (1914-1916). He was awarded the Frank Smart Prize for Zoology by the University of Cambridge for being the best student of the year in this subject in 1916. For his original research work the Christ's College awarded him the Charles Darwin Prize.

For almost three years Prof. Afzal Husain conducted original investigations in Zoology and Entomology at the University of Cambridge ; the Natural History Museum, South Kensington, London ; the Imperial College of Science, London ; and the Victoria University, Manchester. For his research work he received scholarships from his College and grants from the Royal Society, London, the Balfour Research Fund of the University of Cambridge and a special grant from the Secretary of State for India. These scholarships and grants were fitting recognition of his capacities as a research worker.

For sometime Prof. Afzal Husain worked as one of the Demonstrators in the school of Zoology in the University of Cambridge.

Prof. Afzal Husain was selected by the Secretary of State for India for the post of Entomologist (Imperial Agricultural Service) at the Imperial Agricultural Research Institute, Pusa, and he joined that post in January, 1919. In September of the same year he was appointed Entomologist to the Government of the Punjab and Professor of Zoology and Entomology at the Punjab Agricultural College, Lyallpur.

For a year and a half (1925-26) Prof. Afzal Husain acted as the Imperial Entomologist at the Imperial Agricultural Research Institute, Pusa. As Locust Research Entomologist to the Imperial Council of Agricultural Research (1930-33) he initiated research on the Locust problem and laid the foundations of the Locust control which has achieved such remarkable success during recent years.

From March 1933 Prof. Afzal Husain was appointed Principal of the Punjab Agricultural College, Lyallpur and this post he held till October, 1938.

Prof. Afzal Husain was the first Entomologist to the Government of the Punjab and due to his efforts the Entomological Section of the Institute holds the unique position of being the largest Entomological Section in India. Prof. Afzal Husain was appointed Principal of the Punjab Agricultural College at a time when, on account of agricultural slump,

the College was at a very low ebb, but he raised it to a very high level of efficiency and strength, and in course of time, it became one of the best Agricultural Colleges and Research Institutes in the country.

In the University of the Punjab Prof. Afzal Husain was nominated a Fellow quite early in his career, and served on the Faculties of Science and Agriculture. He was a Dean of the Faculty of Agriculture and a Member of the Syndicate for many years. He was appointed Vice-Chancellor of the Punjab University in 1938 and held that post for three terms.

In the University of the Punjab, Prof. Afzal Husain was responsible for starting the Departments of Music and Arts for the women students, and Departments of Statistics and Journalism. He also initiated proposals for creating the Departments of Geography and Pharmacy and inclusion of Sociology as a subject for the degree examination. On his recommendation, the University established a Research Studentship. As Vice-Chancellor Prof. Afzal Husain carried out numerous reforms in the administration and organization of the University of the Punjab.

Prof. Afzal Husain has been responsible for valuable educational and research work in Entomology. Many of his pupils are today holding appointments of responsibility in Entomology in Indian Universities and Research Institutes. His investigations in Entomology cover a wide field, particularly with reference to the desert locust, pests of cotton, sugarcane and fruit trees. He is the author of numerous papers on these subjects.

Prof. Afzal Husain is a Foundation Fellow of the National Institute of Sciences in India and a Member of the Council of the Institute. He is also a Fellow of the National Academy of Sciences, India. He presided over the Agricultural Section of the Indian Science Congress in 1933 and the Entomological Section of the Indian Science Congress during the Jubilee year in 1938.

He represented the Universities on the Central Advisory Board of Education and represents the Universities on the Advisory Board of the Imperial Council of Agricultural Research. In 1943-44 he was the President of the Philosophical Society, Lahore and he is responsible for founding the Entomological Society of India.

Prof. Afzal Husain was a delegate for India to the International Locust Conference at Egypt in 1935. He also represented India on the Permanent Agricultural Committee of the International Labour Office at Geneva in 1938, when he visited important scientific institutions at Geneva, Paris, Brussels, Berlin, Munich, Vienna and Budapest. In 1944 he was sent by the Government of India as a delegate to Agricultural Conference of the Middle East countries.

The Punjab Government have placed on record their appreciation of the "consistently praiseworthy and outstandingly good work" rendered by Prof. Afzal Husain in the Department of Agriculture.

When he relinquished the office of the Vice-Chancellor, Punjab University, in 1944, he was invited by the Government of Bengal to advise them on the reorganization of their Department of Agriculture.

From July 1944 to August 1945 he was a Member of the Famine Inquiry Commission.

He is a member of the Indian National War Memorial Committee and was a member of the delegation of this Committee that visited Military academies in U. S. A., Canada and U. K. during October-November, 1945.

Prof. Afzal Husain has been elected the General President of the Indian Science Congress for 1946. This is the highest appreciation which scientists in India can confer on a student of science.

RAM BEHARI

President, Section of Mathematics

Born at Delhi in 1897, Dr Ram Behari had his early education at St. Stephen's School and St. Stephen's College, Delhi. He had a brilliant school



and college career at Delhi culminating in a First Class first M.A. in Applied Mathematics, from the Punjab University in 1919. He then took the M.A.

degree in Pure Mathematics in 1920, from Government College, Lahore, standing first again and was immediately appointed by St. Stephen's College on its mathematics staff. In 1925 he was awarded the Central State Scholarship by the Government of India for higher study abroad and proceeded to Cambridge where he joined Sidney Sussex College. He took the Mathematical Tripos, Part II of Cambridge University in 1927. Later, he proceeded to Dublin where he worked at Trinity College, under the guidance of Prof. Rowe, and obtained the Ph.D., degree from the University of Dublin in 1932 for his thesis on 'The Differential Geometry of Ruled Surfaces'. He studied for sometime at the University of Sorbonne in Paris. In 1943, he was awarded the U. P. Education Minister's Gold Medal by the National Academy of Sciences, India, for his group of papers on the Differential Geometry of Ruled Surfaces which were assessed as the best papers in Mathematics, published in the *Proceedings* of the Academy during the previous five years. In 1945, the University of Dublin conferred on him the Sc.D. degree in recognition of his research work. He is the first Indian Mathematician to receive this distinction.

Dr Ram Behari is a Fellow of the National Institute of Sciences of India, the Indian Academy of Sciences, and the National Academy of Sciences, India, and is a member of many mathematical societies. He was Secretary of the Indian Mathematical Society for seven years (1936-1943) and conducted the affairs of the Society in an extremely able and efficient manner. He is connected with most of the Indian Universities and other learned institutions in some capacity or other. At several University Centres he has delivered extension lectures. His lectures delivered at Lucknow University are under publication by the University in the form of a monograph. He has published a large number of original research papers in Indian and foreign journals which have been widely reviewed in appreciative terms, and is the author of several text-books. He is now the Head of the Department of Mathematics in the University of Delhi with which he has been closely associated in various capacities since its very inception.

K. B. MADHAVA

President, Section of Statistics

The late Dr Sir Brajendra Nath Seal, former Vice-Chancellor of Mysore University, inaugurated as long ago as 1924, an independent chair for Mathematical Economics and Statistics, the first, and probably the only such, chair in any Indian University and selected as its first (and present) professor, K. B. Madhava. Prof. Madhava is also the first president of the new section of Statistics of the Indian Science Congress. Born in 1895, and graduating with Honours in 1916, he had worked in the research department of Madras University



(1916-1917), as Lecturer in Mathematics in Madras Christian College (1917-1918) and as Assistant Professor of Mathematics, Central College, Bangalore (1918-1924). His publications, commencing from 1916, cover a wide range of subjects of pure Mathematics, Economic Theory, application of statistical methods to nutrition, school health, biometry, acturial science, population and administration. He is a member of several learned societies including the coveted International Institute of Statistics, Econometric Society and the National Institute of Sciences of India, of the last of which he is also a member of council. In 1944 his services were borrowed from Mysore by the Government of India, first as member of the Population Data Committee and later for special investigation on the economics and statistics of road development in India, the analytical work of both of which are based at the Indian Statistical Institute, Calcutta. As Associate of the Institute of Actuaries (1923) he is one of the oldest Consulting Actuaries in India commanding extensive practice.

B. C. GUHA

President, Section of Chemistry

Dr B. C. Guha was born in 1904, had his early education in Bengal and is an alumnus of Calcutta University. He took his B.Sc. and M.Sc. degrees

in Chemistry standing first in First Class in both examinations and carried out research for the M.Sc. degree under the late Sir P. C. Ray. He proceeded to England in 1926 and carried out biochemical researches with particular reference to vitamins in the



laboratories of Prof. (now Sir) Jack Drummond, University College, London, and of Sir Gowland Hopkins of Cambridge University. He took his Ph.D. and D.Sc. degrees of London University and also visited a number of continental laboratories.

Dr Guha was appointed Sir Rash Behary Ghose Professor of Applied Chemistry in 1936. He went on a scientific tour in Europe and America with a Ghose Travelling Fellowship in 1938. He was a delegate of the Indian Science Congress Association to the meeting of the British Association for the Advancement of Science at Cambridge in 1938 and attended the International Physiological Congress at Zurich in the same year as a representative of Calcutta University.

Since July 1944, Dr Guha's services were temporarily lent by Calcutta University as the Chief Technical Adviser to the Food Department, Central Government, at the request of the Government of India. He has been concerned with the recent development of food-processing industries in India. He was lately in the U. K. and the U. S. A. in order to look into the progress in food-technology in these countries.

Dr Guha is well-known in the biochemical world for his researches in varied fields of biochemistry and particularly in the field of food and nutrition. He is an advocate of the synthesis between pure and applied research and has tried to promote the application of modern knowledge of nutrition to the problem of feeding the people of India who are perhaps at the lowest nutritional level among all the nations of the world. Dr Guha is associated with many scientific and cultural bodies in India and is a powerful exponent for the application of science and technology for social progress.

R. E. MORTIMER WHEELER

President, Section of Anthropology and Archaeology

Dr R. E. Mortimer Wheeler was educated at the University of London wherefrom he obtained his M.A. and D.Litt. degrees. The Honorary D.Litt. of Bristol University was also conferred upon him. He was Fellow of the British Academy and Fellow (lately Director) of the Society of Antiquaries of London (Gold Medallist, 1944). Dr Wheeler served in various important capacities. He was Member of the Royal Commission on Historical Monuments (England), formerly Director of the National Museum of Wales, Director of the London Museum, Lecturer in Archaeology in the University of Wales, Lecturer in Archaeology in the University of London, Honorary Director of the London University Institute of Archaeology, and Member of the Ancient Monuments Boards for England and Wales. At present he is Director General of Archaeology in India.

He has carried out archaeological excavations in England, Wales, France and India. Dr Wheeler has an admirable record of War service. In 1914-18, he served in the Royal Artillery on the Western Front, in Italy and in Germany ; became Major in 1917, received Military Cross, and was mentioned in the despatches. In 1939-43, he served in the Royal Artillery in the Battle of Britain, North Africa and Italy and, as a Brigadier, commanded a brigade in the 8th Army and the 5th Army. He took part in the battle of El Alamein, the Tripoli-Tunis campaign, and the landing at Salerno.

K. N. BAGCHI

President, Section of Medical and Veterinary Sciences

Born on the 27th December, 1888, at Samriddhi, in the Sub-division of Chuadanga (district Nadia), where his father the late Dr K. P. Bagchi was a well-known medical practitioner with extensive practice, Rai Bahadur K. N. Bagchi was educated in the Chuadanga Victoria Jubilee High School and passed the Entrance Examination in 1905. After passing his B.Sc. (Hons.) from the Presidency College in 1909, he joined the Calcutta Medical

College where he was a scholar and took his M.B. degree in 1915. He was then appointed to the newly created post of Chemical Analyst to the Government of Bihar and Orissa at Patna, and was deputed to undergo a course of training for one year under the late Dr Chunilal Bose, the Chemical



Examiner to the Government of Bengal, Calcutta. While under training he was very much impressed with Dr Bose's regular and studious habits, thirst for knowledge and zeal for research and tried to imbibe these qualities as much as he could. While at Patna he was responsible for building a new chemical and bacteriological laboratory which is one of the finest public health laboratories in India. When the Prince of Wales Medical College was established at Patna, he was appointed Lecturer and Head of the Department of Chemistry in addition to his own duties as Chemical Analyst to Government and Public Analyst, and was elected a Fellow of the Patna University from among the College Teachers. Early in 1930, he sailed for the U. K. on study leave for higher studies in Chemistry of Food and Drugs under Mr Chaston Chapman, F.R.S., of London, and in September 1931 passed the examination of F.I.C. (now called as F.R.I.C.) in Branch E (chemistry of food, drugs, water, etc.). He is the first Indian and only Bengalee to obtain this diploma which is considered as a hall-mark in analytical chemistry. He also passed the examination in Industrial Bacteriology from the Chelsea Polytechnic, London, and was awarded the Polytechnic Prize for securing the first place among the successful candidates. He joined the University of Berlin in the same year for a course of training in Toxicology in the Pharmacological Institute. He returned to India in January 1932 after an extensive tour all over Europe.

In 1935, he was appointed Chemical Examiner to the Government of Bengal and he returned to his old laboratory where he got his training just 20 years before and subsequently became the Proofessor of Chemistry in the Medical College and Chief Biochemist of the Medical College Hospitals. He has contributed numerous original papers in various scientific journals in India and abroad and was elected a Fellow of the National Institute of Sciences of India in 1940. He was President of the Institution of Chemists (India) for 1939 and 1940 and of the Second All India Pharmaceutical Conference held at Baroda in 1942. He is connected with almost all the learned Societies of India and has been taking keen interest in the Indian Science Congress Association as its member for the last 20 years.

P. DE

President, Section of Physiology

Born at Jagannathpur in the district of Nadia (Bengal), on the 28th of October, 1893, Premankur De, received his early education at the Keshab



Academy, the City School and the City College, Calcutta. He then joined the Medical College, Calcutta and obtained the M.B. degree of the Calcutta University in 1917, securing scholarships every year. Soon after graduation he entered the Bengal Medical Service (Upper) and during World War I he joined

the Indian Medical Service in 1918 and retired as a Captain in 1921. On his reversion to the civil, he was appointed as the Assistant Professor of Pharmacology at the Calcutta School of Tropical Medicine in 1921 under Sir Ram Nath Chopra (then Major Chopra) and worked there for over ten years. Here Professor De distinguished himself as a keen scientist, an experimental worker of high order and a capable teacher. He carried out important researches on Indian Indigenous Drugs, such as, *Boerhaavia diffusa* (Punarnava), emetine, *Saussurea lappa* (Kuth root), *digitalis*, ergot, *Sida cordifolia* (Brela), *Moringa pterygosperma*, etc., and on biological assay of drugs in collaboration with Sir Ram Nath Chopra. On the merit of his work on Indian Indigenous Drugs Prof. De received Dr Chandra Scholarship for three years from 1923-26. While working at the School of Tropical Medicine he prepared himself for the B.Sc. examination of the Calcutta University and passed with Distinction in 1925. In recognition of his excellent researches he was awarded Sir Rashbehari Ghosh Travelling Fellowship of the Calcutta University in 1926-27 for studying improved methods in experimental technique of Physiology and Pharmacology in the United Kingdom. He was also granted study leave by the Government of Bengal. These enabled him to visit different Universities in the United Kingdom, where he stayed for over a year and a half. At Cambridge, Prof. De carried out important investigations with the late Prof. W. E. Dixon, F.R.S., involving complicated experimental technique on Scillaren, a glucoside from *scilla* and on the action of some derivatives of quinine with special reference to local anaesthesia and pulmonary oedema and published the results of the latter investigation in collaboration with the late Prof. Dixon. While at Edinburgh, he worked with the late Prof. A. J. Clark, F.R.S. and Dr Chalmers Watson, Senior Physician of the Royal Infirmary, and carried out interesting researches of great importance on the rate of action of drugs and ions on frog's heart and on unrecognized toxic substances in human faeces. The latter work was published in collaboration with Dr Watson. Prof. De helped in the teaching work of the Department of Pharmacology of the University of Edinburgh and assisted at the advanced course in Practical Pharmacology in the summer term there in 1927. He passed the M.R.C.P. of Edinburgh University in 1928. On his return from abroad he rejoined the Calcutta School of Tropical Medicine and twice officiated (1930 and 1931) as Professor of Pharmacology of that institution during the absence of Lt.-Col. R. N. Chopra.

In 1932 Prof. De was selected as the Professor of Physiology including Biochemistry at the Medical College, Calcutta, in which capacity he has since then been working. Here he started investigation on physiological and biochemical problems and has lately been working on problems of hyperglycaemia. His findings in this subject are of great importance. He is the author of twenty-eight original papers, published both in India and abroad.

He has been elected a Fellow of the Royal College of Physicians of Edinburgh in 1938 and a Fellow of the National Institute of Sciences of India in 1943. He was a member of the Committees of experts appointed by the Government for the establishment of a College of Pharmacy in Calcutta and of a Medical College at Dacca.

P. H. KUTAR

President, Section of Engineering and Metallurgy

Mr P. H. Kutar graduated from the Bombay University, taking his B.A. in 1919 and B.Sc. in 1920 with first class honours in Physics and Chemistry. He was appointed a fellow of the Wilson College and was for some time a lecturer in Physics in that institution. In 1921, he obtained scholarships from the Gimi Trust and the Patel Trust for higher studies in the United States and joined the Pittsburgh



University. After receiving his degree in Metallurgical Engineering he got his M.S. degree in Metallurgy for which he submitted a thesis on "Physical properties and micro-structures of Steel Wires of different compositions". This investigation was carried out under the auspices of the Pittsburgh Tool Steel Wire Co. Later on he worked with Dr S. L. Goodale on Non-metallic Inclusions in Iron and

Steel and made an exhaustive investgiation of existing metallographic knowledge on the subject. In 1925, he joined the Tata Iron & Steel Co. as a Metallurgical Investigator in the Rolling Mills. He was the first Indian Shift Foreman to be appointed in the Rolling Mills. Mr Kutar then earned one promotion after another and became successively Assistant Superintendent of the Rolling Mills East in 1930 ; Superintendent of these Mills in 1933, Assistant General Superintendent (Mills) in 1937, Assistant General Superintendent (General) in 1940 and General Superintendent in 1941. Mr Kutar was the Vice-President of the Mining, Geological and Metallurgical Institute of India during 1942-43.

Outside his technical field, Mr Kutar is a man of varied human interests. He is keenly interested in classical Indian music. He was the President of the Allahabad University Music Conference in 1941, the guest of honour at the All-Bengal Music Conference in 1943-44 and the guest-in-chief at the All-India Music Conference in 1945. He was elected the President of the Bihar Cricket Association in 1945.

[We owe our readers an apology for our inability to publish the presidential address and photographs and life sketches of some of the sectional Presidents, which unfortunately did not reach us when we went to the press.—Ed., *Science and Culture*.]

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